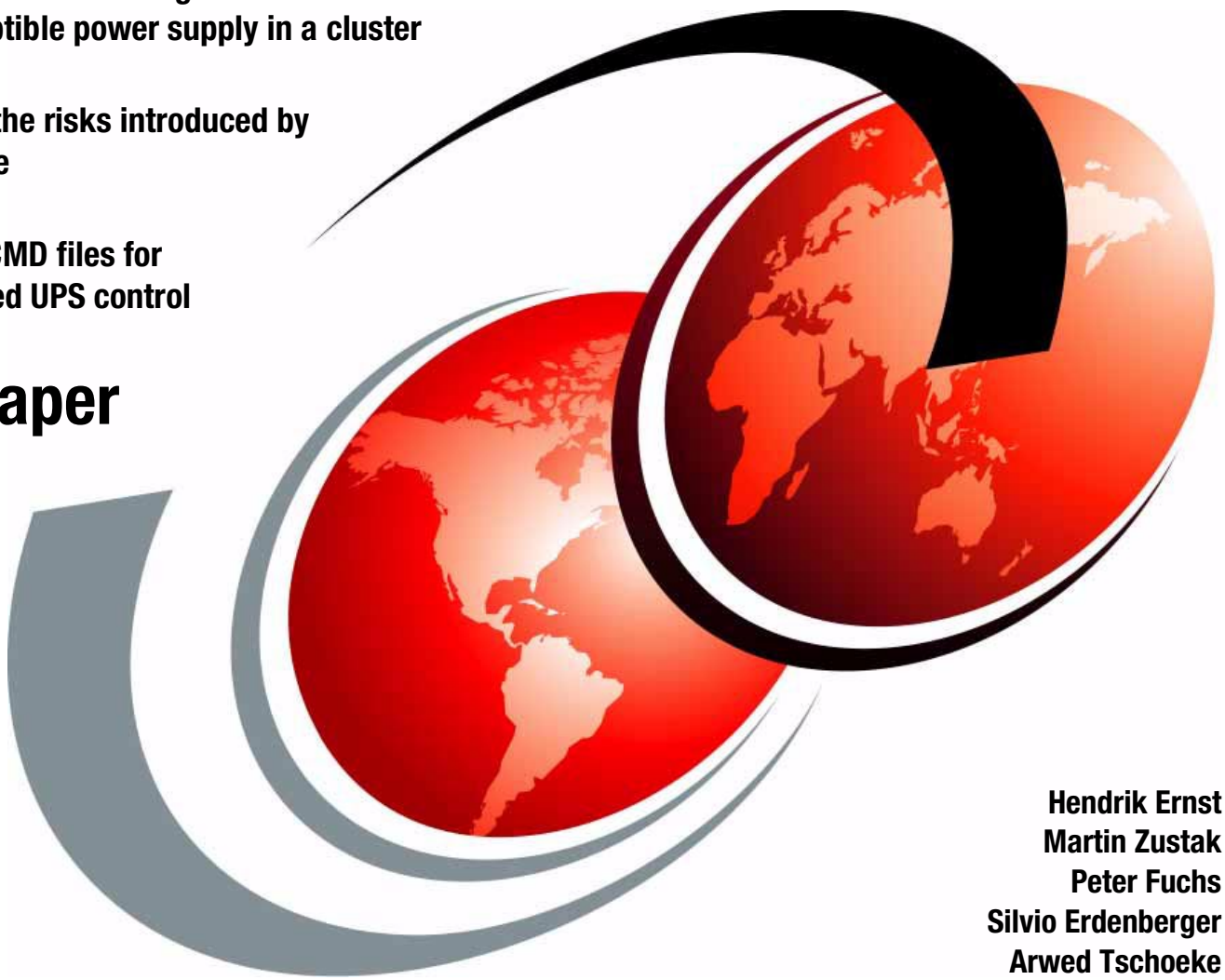
Implementing UPS Configurations with Microsoft Cluster Server

- Describes how to configure an uninterruptible power supply in a cluster
- Minimize the risks introduced by UPS failure
- Includes CMD files for streamlined UPS control

Redpaper



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International Technical Support Organization

Implementing UPS Configurations with Microsoft Cluster Server

March 2001

Take Note!

Before using this information and the product it supports, be sure to read the general information in Appendix E, “Special notices” on page 87.

First Edition (March 2001)

This edition applies to Microsoft Windows NT 4.0 Enterprise Edition with Service Pack 5 or 6a and APC PowerChute PLUS 5.2 for Windows NT.

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Contents

Preface v
The team that wrote this redpaper v
Comments welcome vi

Chapter 1. The problem 1

Chapter 2. APC hardware and software background 3
2.1 Smart-UPS family 4
2.1.1 SU2200RMXLINET 4
2.1.2 SU3000RMINET (5U unit) 6
2.1.3 SU5000RMINET 8
2.2 Symmetra 10
2.2.1 Symmetra Masterframe/Miniframe 11
2.3 UPS options 14
2.3.1 APC AP9607 Interface Expander Card 14
2.3.2 AP9606 Web/SNMP Management Card 15
2.3.3 Redundant Switch 16
2.4 APC monitoring and management software 18
2.4.1 PowerChute PLUS 18
2.4.2 PowerChute network shutdown 23
2.4.3 Signaling cables 24
2.5 Power plugs and connectors 25

Chapter 3. UPS configurations for cluster 27
3.1 General UPS configuration rules 27
3.1.1 Timing of UPS actions 28
3.1.2 UPS capacity planning 29
3.1.3 Recovery 30
3.2 Single power line solutions 31
3.2.1 Control flow in UPS.CMD 33
3.2.2 Example configuration with a single UPS 34
3.2.3 Preparing both nodes 34
3.2.4 Installing PowerChute PLUS on the node with a black serial cable . . 35
3.2.5 Configuring PowerChute PLUS on the node with a black serial cable 38
3.2.6 Installing PowerChute PLUS on the node with a grey serial cable . . . 44
3.2.7 Configuring PowerChute PLUS on the node with a grey serial cable . 47
3.3 Solutions with double power lines 51
3.3.1 Solution with multiple UPS units and Redundant Switch 51
3.3.2 Solution with two UPS units 52
3.3.3 Control flow in UPS.CMD 55
3.3.4 Example configuration with two UPS units 57
3.3.5 Preparing both nodes 58
3.3.6 Installing PowerChute PLUS on both nodes 58
3.3.7 Configuring PowerChute PLUS 61

Chapter 4. The command file UPS.CMD 67
4.1 Global Variables in the Command File UPS.CMD 67
4.2 Parameter UPSOnBattery 68
4.2.1 MoveClusterGroups 69
4.2.2 GroupOffline 70
4.3 Parameter SingleUPSOnBattery 71

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4.4 StartUp Parameter 72

Appendix A. Downloading the additional material 73
A.1 Using the additional material 73
A.2 Readme 73
A.2.1 Windows NT 4.0 73
A.2.2 Windows 2000 74

Appendix B. UPS.CMD 77

Appendix C. DELAY3.EXE source 81

Appendix D. Referenced documents 85

Appendix E. Special notices 87

Preface

This redpaper is the product of a collaboration of specialists from American Power Conversion, Inc. (APC), Computer Service GmbH (CSG), and IBM. The intention was to find a solution for implementing uninterruptible power supplies (UPS) in a Microsoft Cluster Server environment. To our knowledge, this is the first document that covers this topic.

The intention in writing this redpaper was to develop a solution for using APC UPS units in a two-node Microsoft Cluster Server environment. We discuss the problems that we faced during the development of the solutions.

We introduce the APC hardware equipment we used for the implementation. Two solutions are presented: using either one UPS or two UPS units. In the last chapter we describe the result of our efforts — the command file UPS.CMD.

The team that wrote this redpaper

This redpaper was produced by a team of specialists from around the world:

Martin Zustak joined APC in September 1997 and worked as Technical Support Engineer focused on Microsoft and UNIX-related issues. Currently Martin holds the position of Continuous Improvement Leader, focusing on quality, developing processes and leading projects in the APC Support Organization.

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This redpaper was reviewed and edited at the ITSO Raleigh Center. Thanks to the following people for their assistance:

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Gail Christensen
Christine Johnson

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Chapter 1. The problem

How can servers be protected against power failures? Usually redundant power supplies and redundant power cords connected to different power lines are used for basic protection.

The failure of one of these components does not affect the operation of the server. To protect the system against a complete power loss, an uninterruptible power supply (UPS) is required. If software such as PowerChute PLUS is installed on the system and a communication link is set between the UPS and the server, PowerChute PLUS can stop the applications and shut down the operating system.

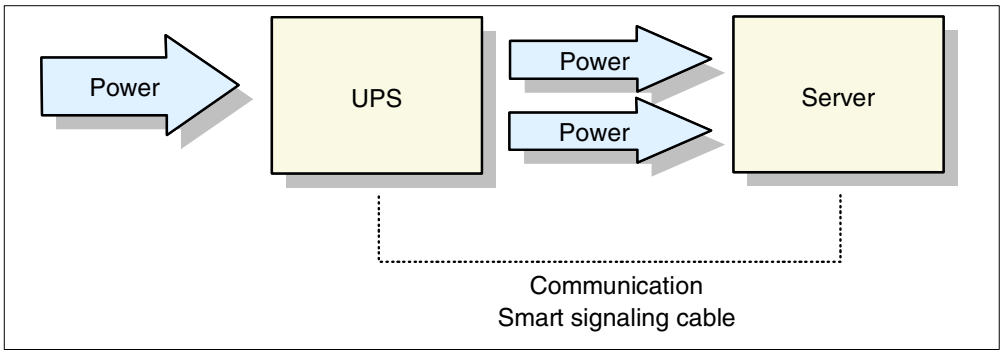

Figure 1. UPS with one server

For larger solutions such as a Microsoft Cluster Server (MSCS) configuration, a single UPS may not provide sufficient protection. The run-time capacity of one UPS is inadequate in most cases for two servers with shared storage. Additionally, one UPS is a single point of failure. Thus, you need two or more UPS units. However, in an MSCS environment with one or two UPS units you have certain problems:

- **Application handling:** In an MSCS environment you cannot simply stop an application; the cluster application must be set to offline with the cluster administration tool. If the application is stopped by normal procedures (such as PowerChute PLUS's Application Shutdown or application-specific stop procedure), then the application would be considered as failed and restarted by the cluster resource monitor.
- **Server status:** If a power loss occurs on one server, a communication about the status of the other server is required. If only the local server is affected by the power loss, then it makes sense to move all cluster resources from this node to the surviving one. Otherwise, if no other node is available or if the other node will also shut down, then the resources must be set to offline.
- **Server power cabling:** How are power cables connected? Some servers have a N+1 redundancy in power supplies. If you connect a server with three power supplies and three power cords to two power circuits, you have at least two power supplies on the same circuit. It is possible that this circuit will fail. With the one remaining power supply, the server will not work. In the case of a server with two power cords, you could try to connect them to different UPS units. But then you have the communication problem as described below.

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- **UPS monitoring:** PowerChute PLUS can monitor only one UPS at a time, independent of the type of communication link to this UPS (serial line or network). If you attach more than one UPS to a server, then the server cannot receive signals from all UPS units. Thus, you cannot attach more than one UPS to a server.
- **Storage protection:** You must guarantee that the last component in your cluster to fail is the shared storage, because the cluster service will stop immediately when it loses access to shared storage.
- **Storage power cabling:** The shared storage typically consists of more than one component (RAID controller and multiple drive enclosures). The wrong order of failure of these components may destroy your RAID arrays. For example, if a drive enclosure with more than one drive of a RAID-5 array fails before the RAID controller fails, the RAID controller would mark the whole array as dead.

In Chapter 3, “UPS configurations for cluster” on page 27, we develop solutions for these cluster-specific problems.

Chapter 2. APC hardware and software background

In the following chapters, we describe some UPS units that are important for cluster solutions. All described UPS units are by American Power Conversion (APC). You can also get the Smart UPS units as an IBM option.

For a correct sizing of the UPS capacity you need some background information on power.

They are different power types in alternate current (AC):

- Real power
- Blind or reactive power
- Apparent power

Real power is the actual power dissipated by the load and is calculated as follows:

$$P = U \cdot I \cdot \cos\langle\varphi\rangle$$

Where:

P	Real power
U	RMS voltage
I	RMS current
φ	Phase angle (phi) between the current and voltage

However, with a purely resistive load, there is no phase shift between current and voltage, hence cos(φ)=1.

$$P = U \cdot I$$

Blind power, or reactive power, is the power that swings between generator and load without any work in the load.

$$Q = U \cdot I \cdot \sin\langle\varphi\rangle$$

Blind power comes into coexistence if there is a phase shift between current and voltage.

Apparent power is the quadratic sum of real and blind power:

$$S^2 = P^2 + Q^2$$

$$S = \sqrt{P^2 + Q^2}$$

In a switching power environment (power supplies in the server), a cos(φ)=0.707 is assumed. So we can calculate:

$$P = \frac{S}{\cos(\varphi)} = S \cdot 1,414$$

For better calculating we assume:

$$P = S \cdot 1,5$$

This was a short introduction to power, but now we will describe the UPS units in detail.

2.1 Smart-UPS family

The Smart-UPS family is a line-interactive UPS designed to provide clean, reliable AC power. Under normal line conditions, the UPS provides power from the utility line to the output loads. The UPS's bidirectional inverter is always running. When operating online the inverter runs backwards to charge the batteries and maintain an optimum float charge on the internal battery. A surge suppression and filtering network protects the load from surges and EMI/RFI noise. SmartTrim and SmartBoost compensate for high and low input voltages without drawing power from the battery.

The UPS continuously monitors the line in anticipation of utility failure and prepares the inverter for synchronous transfer of the load. Upon occurrence of a utility voltage failure such as a blackout, severe brownout or overvoltage, the UPS transfers the load to power derived from the internal battery. The voltage waveshape delivered during battery operation is a low-distortion sine wave. Resynchronization and retransfer to power derived from the utility is automatic upon recovery of the line voltage to within the normal range.

The UPS features user-replaceable batteries. Users can replace batteries without having to remove power from the loads or send the UPS in for service.

The complete range of the APC Smart-UPS family is available at:

`http://www.apcc.com/products/smart-ups/index.cfm`
`http://www.apcc.com/products/smart-ups_rm/index.cfm`

2.1.1 SU2200RMXLINET

SU2200RMXLINET is a rack-mount UPS offering extended run-time (XL). Increased on-battery run time is obtained with the addition of up to 10 optional battery packs. Optional battery packs may be added as needed in the field, since each battery enclosure includes an auxiliary battery input connector. In this fashion, battery packs may be arranged to meet the needs of the application.

Table 1. Technical specifications

VA/W ratings	Maximum 2200 VA or 1600 W
Type of external battery packs	SU48RMXLBP (8 x 12 V DC and 17 Ah. Nominal system voltage 48 V DC)
Dimensions: UPS	Height 22.2 cm (5U) x width 48.3 cm x depth 45.1 cm. (Depth is measured from front of bezel to back of chassis, with a half-inch allowance for screws and outlets.)
Dimensions: battery pack	Height 17.8 cm x width 48.3 cm x depth 45.7cm
Maximum input current	12 Amps (for nominal line voltages indicated and load p.f. ~ 0.7 includes load current)
Input resettable circuit breaker rating	20 Amps
Input wiring devices	IEC 320 C20 16 Amp outlet (1x)
Hardwiring input option	Not available
Output wiring devices	IEC 320 C19 16 Amp outlet (1x) IEC 320 C13 10 Amp outlet (8x)
Software monitoring and management	940-0024C black APC serial cable (smart-signaling mode)
Software compatible with the UPS	PowerChute PLUS 5.1 for Windows NT PowerChute PLUS 5.2 for Windows NT/2000
Replacement battery cartridge	RBC11

The typical SU2200RMXLINET on-battery run times versus VA load, in minutes (with SU48RMXLBP) are as follows:

Table 2. Run time SU2200RMXLINET

Load	internal battery	1 battery pack	2 battery packs	3 battery packs	4 battery packs	5 battery packs
1000VA	25	120	225	335	440	550
1200VA	20	91	180	270	360	450
1400VA	16	73	150	225	300	375
1600VA	13	60	120	185	250	315
1800VA	11	52	105	160	220	280
2000VA	9	44	87	140	190	245
2200VA	8	38	75	120	170	215

The UPS is furnished with one input line cord terminated with a CEE7/7 plug and three 1.8 m long output cords appropriate for connection to equipment with 10 Amp IEC320 appliance receptacles. There is also a set of 19'' rack mounting run time in the package, together with L-bracket mounts, which adjust for different depth racks and support the weight of the UPS, allowing the unit to slide in place and for easy securing of the rack mount ears.

The UPS was designed to mount to any standard EIA RS-310 (ANSI C83.9) 19'' equipment rack.

More information available at:

`http://www.apcc.com/products/techspecs/index.cfm?base_sku=SU2200RMXLINET`

2.1.2 SU3000RMINET (5U unit)

SU3000RMINET is a rack-mounted UPS with expandable run time via one battery pack.

Table 3. Technical specifications

VA/W ratings	Maximum 3000 VA or 2250 W
Optional battery pack	SU48BP (4 x 12 V DC and 17 Ah. Nominal system voltage 48 V DC). Only one pack can be connected. The battery pack itself isn't rack-mountable and must be placed on a supporting tray behind the UPS (SU035).
Dimensions: UPS	Height 22.2 cm x width 48.3 cm x depth 45.1 cm. (Depth is measured from front of bezel to back of chassis, with a half-inch allowance for screws and outlets.)
Battery pack	Height 21.6 cm (5U) x width 17.0 cm x depth 43.9 cm
Maximum input current	15 Amps (for nominal line voltages indicated and load p.f. ~ 0.7 includes load current)
Input resettable circuit breaker rating	20 Amps
Input wiring devices	IEC 320 C20 16 Amp outlet (1x)
Hardwiring input option	Not available
Output wiring devices	IEC 320 C19 16 Amp outlet (1x) IEC 320 C13 10 Amp outlet (8x)
Software monitoring and management	940-0024C black APC serial cable (smart-signaling mode)
Software compatible with the UPS	PowerChute PLUS 5.1 for Windows NT PowerChute PLUS 5.2 for Windows NT/2000
Replacement battery cartridge	RBC11

The typical SU3000RMINET on-battery run times versus VA load, in minutes (with SU48BP) are as follows:

Table 4. Run time SU3000RMINET

Load	Internal battery	With external battery pack
1000VA	26	73
1200VA	20	58
1400VA	16	42
1600VA	13	35
2000VA	10	25

Load	Internal battery	With external battery pack
2200VA	8	22
2500VA	7	18
3000VA	5	13

The UPS is furnished with one input line cord terminated with a CEE7/7 plug and three 1.8 m long output cords appropriate for connection to equipment with 10 Amp IEC320 appliance receptacles. There is also a set of 19" rack mounting ears in the package, together with L-bracket mounts, which adjust for different depth racks and support the weight of the UPS, allowing the unit to slide in place and for easy securing of the rack mount ears.

The UPS was designed to mount to any standard EIA RS-310 (ANSI C83.9) 19" equipment rack.

More information is available at:

`http://www.apcc.com/products/techspecs/index.cfm?base_sku=SU3000RMINET`

Figure 2. APC Smart UPS 3000 — front view

Figure 3. APC Smart UPS 3000 — rear view

In Figure 2 and Figure 3, you can see the APC Smart UPS 3000 that you can get as an IBM option. Technical data is identical with the 5U model, but the option to increase the run time with an additional battery pack is not available.

2.1.3 SU5000RMINET

SU5000RMINET is a rack-mount UPS. The extended run time feature isn't available for this model.

Table 5. Technical specifications

VA/W ratings	Maximum 5000 VA or 3750 W
Dimensions: UPS	Height 22.9 cm (5U) x width 43.9 cm x depth 66.5 cm. (Depth is measured from front of bezel to back of chassis, with a half-inch allowance for screws and outlets.)
Maximum input current	30 Amps (for nominal line voltages indicated and load p.f. ~ 0.7 includes load current)
Input resettable circuit breaker rating	30 Amps
Input wiring devices	Hardwired only
Hardwiring input option	Yes
Output wiring devices	IEC 320 C19 16 Amp outlet (2x) IEC 320 C13 10 Amp outlet (8x)
Software monitoring and management	940-0024C black APC serial cable (smart-signaling mode)
Software compatible with the UPS	PowerChute PLUS 5.1 for Windows NT PowerChute PLUS 5.2 for Windows NT/2000
Replacement Battery Cartridge	2x RBC12

The typical SU5000RMINET on-battery run times versus VA load, in minutes are as follows:

Table 6. Run time SU5000RMINET

Load	Internal battery
1000 VA	64
1200 VA	50
1400 VA	39
1600 VA	32
2000VA	23
2200 VA	20
2500 VA	16
3000 VA	11
3500 VA	10
4000 VA	8
4500 VA	7
5000 VA	5

The UPS is furnished with six 1.8 m long output cords appropriate for connection to equipment with 10 Amp IEC320 appliance receptacles. There is also a set of 19'' rack mounting ears in the package.

The UPS was designed to mount to any standard EIA RS-310 (ANSI C83.9) 19'' equipment rack.

More information is available at:

`http://www.apcc.com/products/techspecs/index.cfm?base_sku=SU5000RMI5U`

Figure 4. APC Smart UPS 5000 — front view

Figure 5. APC Smart UPS 5000 — rear view

2.2 Symmetra

You cannot buy Symmetra as an IBM option. The Symmetra is available only from APC.

2.2.1 Symmetra Masterframe/Miniframe

The Symmetra is an uninterruptible power array system, designed for large-scale loads. It provides conditioned, reliable AC power to load equipment, and provides protection from power blackouts, brownouts, swells, sags, surges and interference. The Symmetra Power Array system comprises either a Miniframe or a Masterframe, and a variable set of modules (see 2.2.1.4, “VA ratings” on page 12). Both battery modules and power modules are available.

A battery module contains 4-12 batteries to increase the run time of a Symmetra Power Array. A power module has a main intelligence module (2.2.1.2, “Control” on page 12) and some power supplies that provide power to the battery charger and the MIM. You can use two or more battery modules, but you must use one power module. The small modules are Miniframes and the larger modules are Masterframes.

A Miniframe system can be configured to deliver a maximum output of 8 kVA, and a Masterframe system can deliver a maximum of 16 kVA.

Figure 6. Symmetra Masterframe and Miniframe

The power processing system delivers conditioned AC output power with a low-distortion sine wave. Under normal operating conditions, power is received from the AC main (utility) power source, conditioned by the power processing system, and delivered to the load equipment. In the event of an AC main power source failure, the power processing system receives power from the battery source (battery modules), converts it to conditioned AC, and delivers it to the load equipment. When the AC main power source is present, the power processing system also maintains the battery source at full charge.

The power processing system in Symmetra is comprised of one or more power modules. Each power module contains the electronic components for a complete 4 kVA UPS, including the rectifier, charger, and inverter. When two or more power modules are present, they operate in parallel, sharing the load equally. By configuring the system with at least one more power module than is required to power the load (a redundant power module), Symmetra can sustain a power module failure and still deliver full power to the load equipment. When the failed module is identified by the control/user interface system, an alarm is initiated to notify the user of the module failure. The hot-swappable module can be replaced by the user, without the need to power down the load equipment.

A Symmetra Miniframe provides bays for up to three power modules, and a Masterframe provides bays for up to five. This affords the full system capacity (8 kVA and 16 kVA respectively), plus one redundant power module.

2.2.1.1 Battery source

The battery source is comprised of parallel, hot-swappable, 120 V battery modules. These are housed in the Symmetra frame, and in an optional XR Extension Battery frame. A Symmetra Miniframe provides bays for up to two battery modules, and a Masterframe provides bays for up to four. Both of these frames can be connected to an XR Extension Battery frame. Additional battery modules increase battery run time.

2.2.1.2 Control

Symmetra incorporates a main intelligence module (MIM) that continuously monitors the system. The MIM does the following:

- Coordinates the initial startup of the system
- Transfers it into and out of bypass mode
- Transfers the power source between the main AC power and the battery source
- Coordinates shutdown operations
- Gathers data about the system components
- Delivers it to the Powerview interface and the computer interface ports

System status monitoring and reporting data includes the current predicted run time, the status of individual battery and power modules, the size of input and output voltage, the input and output voltage frequency, and the size and status of the output load.

2.2.1.3 Alarm condition detection

The control/user interface system monitors Symmetra for alarm conditions. If an alarm condition is detected, the Powerview user interface initiates an audible and visual alarm. Alarm conditions include on-battery, low battery, module faults, overloads, loss of redundancy and a variety of other default and user-defined events.

More information is available at:

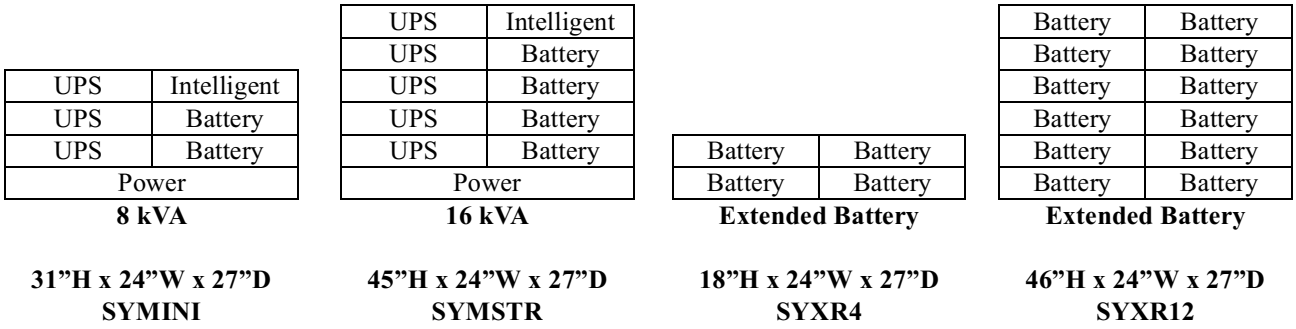
`http://www.apcc.com/products/symmetra/index.cfm`

2.2.1.4 VA ratings

The Symmetra comes in different VA ratings:

- Miniframe: 4 - 8 kVA
- Masterframe: 8 - 16 kVA

(always + one 4 kVA power module for N+1 redundancy)



APC part numbers:

- SY4KEXI Miniframe with 1 PM (4 kVA) expandable to 8 kVA redundant
- SY8KI Miniframe with 2 PM (8 kVA) expandable to 8 kVA redundant
- SY8KEXI Masterframe with 2 PM (8 kVA) exp. to 16 kVA redundant
- SY12KEXI Masterframe with 3 PM (12 kVA) exp. to 16 kVA redundant
- SY16KI Masterframe with 4 PM (16 kVA) exp. to 16 kVA redundant
- SYPM Additional power module
- SYBATT Additional battery module
- SYXR4 Extended battery frame for up to 4 modules (not included)
- SYXR12 Extended battery frame for up to 12 modules (not included)

You can find the IBM part numbers in Appendix C of the *IBM Paper Configurator*. This document is available from `http://www.pc.ibm.com/support/`.

Table 7. Run time chart

VA load	Number of batteries installed										
	1	2	3	4	5	6	7	8	9	10	12
2000	15	40	66	96	126	162	192	222	258	288	354
3000	9	23	40	58	78	96	120	138	156	180	222
4000	6	15	27	40	53	66	84	96	114	126	156
5000	n/a	11	20	29	40	51	62	72	84	96	120
6000	n/a	9	15	23	31	40	49	58	66	78	96
7000	n/a	7	12	18	25	32	40	47	55	60	79
8000	n/a	6	10	15	21	27	33	40	46	53	66
9000	n/a	n/a	9	13	18	23	28	34	40	46	58
10000	n/a	n/a	7	11	15	20	24	29	34	40	51
12000	n/a	n/a	6	9	12	15	19	23	27	31	40
14000	n/a	n/a	n/a	7	10	12	15	18	22	25	32
15000	n/a	n/a	n/a	6	9	11	14	17	20	23	29
16000	n/a	n/a	n/a	6	8	10	13	15	18	21	27

For recommendations about Symmetra wiring, see the PDF file at the following address:

http://sturgeon.apcc.com/techref.nsf/umanuals/094362544B00279C8525675C006FAEE2?OpenDocument

2.3 UPS options

There are many options for UPS units available, such as Interface Expander Cards or WEB/SNMP Management Cards, which we describe in the next sections.

2.3.1 APC AP9607 Interface Expander Card

The UPS Interface Expander (AP9607) is an accessory that provides two additional computer interface ports for your APC UPS equipped with a SmartSlot accessory slot. It allows the UPS to work in conjunction with PowerChute PLUS software to provide safe system shutdown in extended power outages for up to three network servers or other devices.

Since the computer interface port of the UPS remains available while using the Interface Expander, it is possible to provide advanced UPS and power management functions to all protected devices. The Interface Expander draws power from the UPS. It monitors the UPS and reports power conditions (for example, On Battery, Low Battery, On Line) to all attached devices.

The communication between an APC UPS and a connected server can be of two types: simple signaling or smart signaling. A master server is a server connected to the advanced computer interface port of the UPS via the black smart-signaling cable (#940-0024C). This server uses PowerChute PLUS, configured for smart signaling, to monitor and control the UPS. Although the advanced port on the UPS can provide simple signaling, we strongly recommend using it for smart signaling with the advanced capabilities of PowerChute PLUS.

Servers connected to the basic ports of the Interface Expander via the grey simple signaling cable (#940-0020B for Windows NT/Novell/OS2 or 940-0023A for UNIX systems) use simple signaling with PowerChute PLUS to provide UPS shutdown capabilities and advanced notification features. If you are running PowerChute PLUS on these servers, you must configure it for simple signaling.

More information is available at:

http://www.apcc.com/products/management/shareups_smartslot.cfm

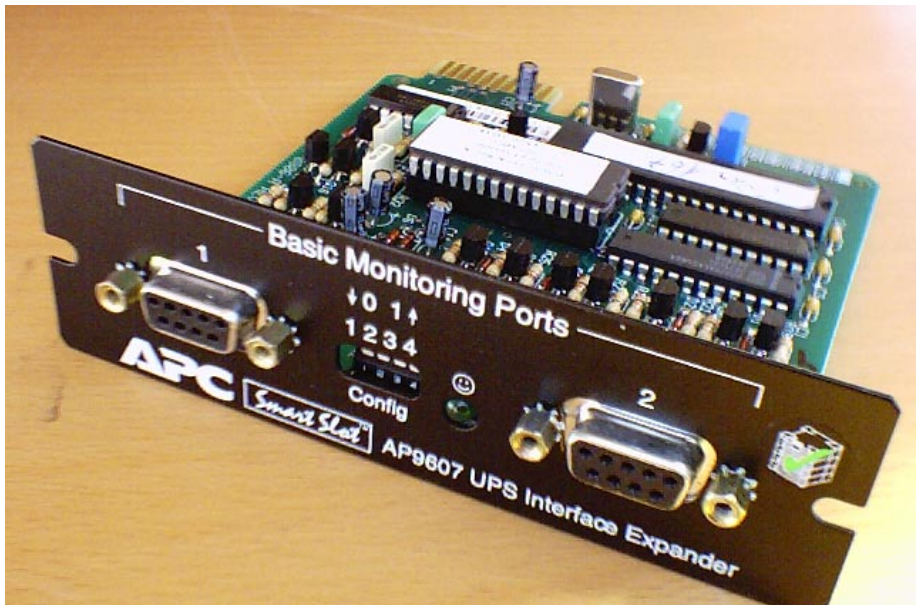


Figure 7. AP9607 — APC SmartSlot Interface Expander Card

2.3.2 AP9606 Web/SNMP Management Card

The AP9606 Management Card provides the hardware and firmware needed to connect your APC UPS to a 10 Mbps Ethernet network and use that network for remote (over the network) management of the Management Card, its UPS, and a Measure-UPS. The Management Card also allows you to use a terminal for local management.

The Web/SNMP Management Card provides many features to ease and enhance network management of APC UPS systems and accessories. Some of the features include:

- Complete configuration and control of Smart-UPS, Matrix-UPS, Symmetra and Measure-UPS via a built-in intuitive Web interface
- A console interface that is fully featured and easy to use
- SNMP management (sets and traps)
- Remote console access via Telnet
- Environmental SNMP traps from APC's Measure-UPS environmental monitoring device
- Graceful server shutdown through the network with APC's PowerChute PLUS software
- Multiple server shutdown through the network with APC's PowerChute Network Shutdown software
- Windows 95/NT 4.0 GUI Configuration Wizard with mass configuration support

More information available at:

`http://www.apcc.com/products/management/web_snmp_card.cfm`

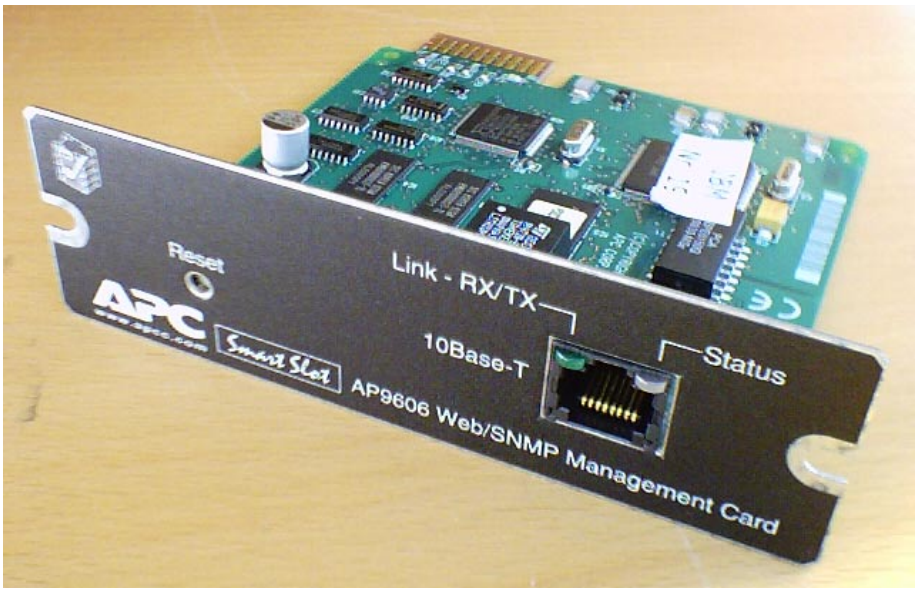


Figure 8. AP9606 — APC Web/SNMP Card

2.3.3 Redundant Switch

The Redundant Switch is a high availability UPS accessory designed to provide clean, reliable AC power. It provides a seamless transfer to an alternative AC source when the input is outside the acceptable range. It can withstand zero to twice the nominal input voltage, while preventing any possibly damaging transients or gaps in output voltage from reaching the protected equipment.

The Redundant Switch should be used with two identical Smart-UPS models, thus providing mirrored Smart-UPS protection to your critical loads. The Redundant Switch transfers the load to the mirrored Smart-UPS unit should the output voltage from the preferred Smart-UPS unit fall outside the acceptable range. Transfer of the load to the mirrored UPS happens automatically, ensuring virtually continuous AC power availability and availability of safe server shutdown. The Redundant Switch is phase-locked to the utility, and will provide as seamless a transfer between AC sources as possible.

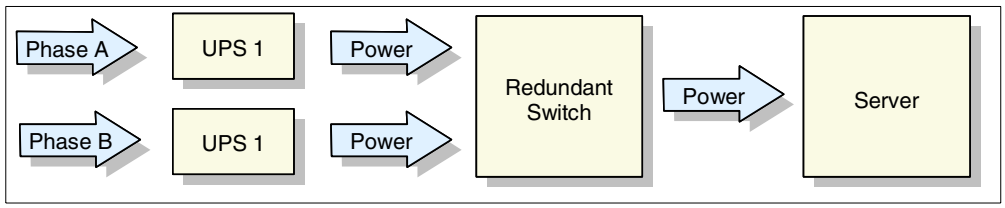


Figure 9. Redundant Switch

APC has created this cost-effective method to increase the AC power availability of your protected network equipment. An important advantage of this solution is that you can feed power to the two Smart-UPS units from two separate AC circuits, further increasing system availability. This fault-tolerant product combination allows monitoring and line filtering of these two separate AC sources up to 3000VA.

The use of a double pole transfer switch by default makes the Redundant Switch fault tolerant. A single point of failure in the electronics does not cause a dropout of the output voltage. The transfer switch must select one input or the other, which are both acceptable, by definition, when a single fault in the Redundant Switch occurs.

The Redundant Switch is furnished with brackets and slides for mounting in standard 19" rack systems. Brackets for 23" applications are available as an accessory.

With the Redundant Switch SU044-1 you have two redundant UPS units.

SU044-1 is designed to work with two identical SU2200RMXLINET or two SU3000RMINET UPS.

Table 8. Technical specifications

VA ratings	Maximum 3000 VA or 2250 W (2x SU2200RMXLINET or SU3000RMINET)
Dimensions	Height 4.45 cm (1U) x width 43.2 cm x 23 cm
Maximum input current	16 Amps (for nominal line voltages indicated and load p.f. ~ 0.7 including load current)
Input wiring devices	IEC 320 C20 16 Amp outlet (2x)
Hardwiring input option	Not available
Output wiring devices	IEC 320 C19 16 Amp outlet (1x) IEC 320 C13 10 Amp outlet (2x)
EPO switch (emergency power off)	Yes
Software monitoring and management	940-0024C black APC serial cable (smart-signaling mode)
Software compatible with the RS	PowerChute PLUS 5.1 for Windows NT PowerChute PLUS 5.2 for Windows NT/2000

The Redundant Switch is furnished with one input line cord terminated with a CEE7/7 plug. There is also a set of 19'' rack mounting ears in the package, together with L-bracket mounts, which adjust for different depth racks and support the weight of the RS, allowing the unit to slide in place and for easy securing of the rack mount ears.

The Redundant Switch was designed to mount to any standard EIA RS-310 (ANSI C83.9) 19'' equipment rack.

More information is available at:

`http://www.apcc.com/products/accessories/redundant.cfm`

Figure 10. Redundant Switch

For the Redundant Switch SU044-1 we have a sample solution in 3.3.1, “Solution with multiple UPS units and Redundant Switch” on page 51.

2.4 APC monitoring and management software

2.4.1 PowerChute PLUS

PowerChute PLUS software provides UPS manageability and safe system shutdown for desktops, workstations, and servers protected by APC UPSs. The software enables you to monitor and control any APC UPS that has a serial interface port.

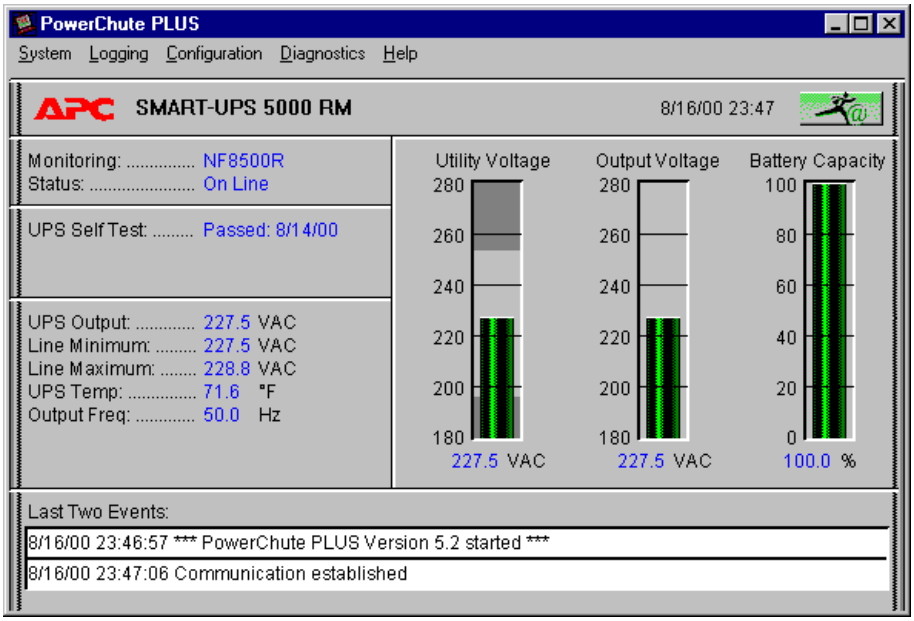


Figure 11. PowerChute PLUS User Interface Module

2.4.1.1 Overview of PowerChute PLUS

PowerChute PLUS provides the following features:

- Orderly shutdown of a network file server or a host computer in the event of an extended AC power failure

- User notification of impending shutdown
- Power event and data logging
- Auto-restart upon power return
- UPS battery conservation features
- Diagnostic and management features, such as scheduled server shutdowns, interactive/scheduled battery testing, and detailed power quality logging
- Real-time graphical displays of transient data, such as battery voltage, UPS load, utility line voltage, run time remaining, battery capacity, and battery voltage

2.4.1.2 PowerChute PLUS Structure

The PowerChute PLUS software consists of two main components:

1. The **UPS Monitoring Module**, or “server,” communicates with the UPS and the User Interface Module, logs data and events, notifies users of impending shutdowns, and when necessary, shuts down the operating system.
2. The **User Interface Module** consists of the PowerChute PLUS Main Screen and the System, Logging, Configuration, Diagnostics, and Help menu options. The User Interface Module lets you access real-time data from the local UPS Monitoring Module or over a network from UPS Monitoring Modules connected to other servers. Data includes UPS output, line minimum/maximum voltage, UPS temperature, output frequency, ambient temperature, humidity, and UPS status. The User Interface Module also displays event text for the two most recent events and bar graphs that you can configure to display any three of the following:
   – Utility voltage data
   – Battery voltage data
   – UPS load data
   – Run time remaining
   – Battery capacity
   – Output voltage
   – UPS load

More information is available at:

`http://www.apcc.com/products/management/pcp_win2000.cfm`

2.4.1.3 PowerChute events

Events are occurrences related to your APC UPS and range in severity from informational (not critical) to severe (critical). If any of the critical events occur (see the list below), you must ensure that the Cluster Groups are either moved to the other node, set offline or the administrator is immediately notified and will take appropriate action. For most events, you can configure PowerChute PLUS to take any or all of the following seven actions.

- Log the event.
- Send early warning pop-up messages to specified administrators
- Broadcast messages to users on the network
- Shut down the host computer

- Run a command file (an external executable file)
- Page users
- Send e-mail to notify users that the event occurred

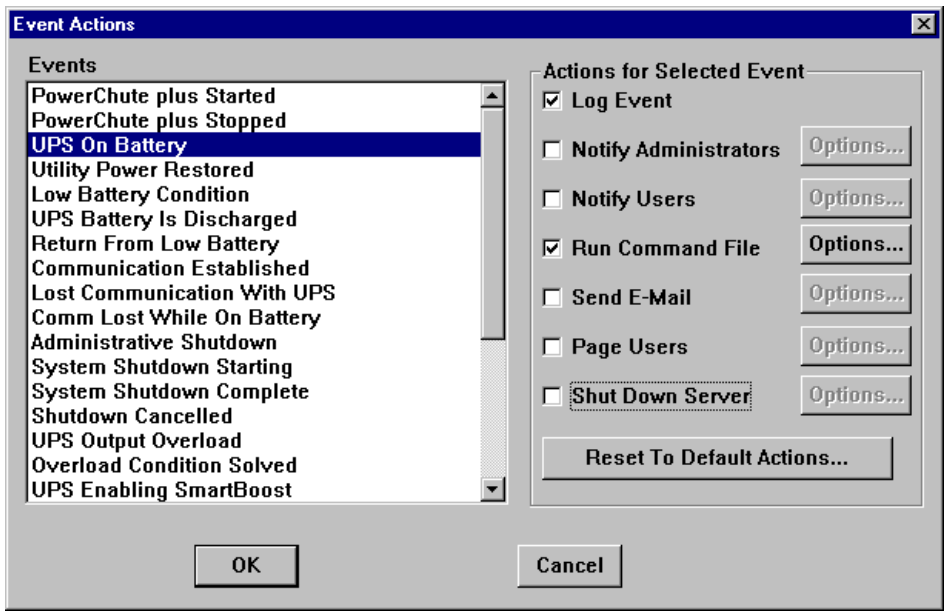


Figure 12. PowerChute PLUS Event Actions Menu (Go to Main Menu-Configuration-Event Actions)

2.4.1.4 Smart UPS events

The critical events monitored are as follows:

- **UPS On Battery**

  The UPS has switched to battery power due to one of the following situations:

  – High input line voltage
  – Brownout
  – Blackout
  – Small momentary power sag
  – Small momentary power spike
  – Deep momentary power sag
  – Large momentary power spike
  – Simulated power failure

  RECOMMENDED ACTION: Run the command file UPS.CMD to either move or set the Cluster Groups offline. This script is described in Chapter 4, “The command file UPS.CMD” on page 67.

- **Low Battery Condition**

  The amount of UPS run time remaining has reached the Low Battery Signal Time. For example, configuring the Low Battery Signal Time to 10 minutes causes PowerChute PLUS to initiate low battery shutdown when the UPS is on battery and 10 minutes of run time remain.

  RECOMMENDED ACTION: Run the command file UPS.CMD to either move or set the Cluster Groups offline. This script is described in Chapter 4, “The command file UPS.CMD” on page 67.

- **Comm Lost While On Battery**

  Communication with the UPS has been lost while the UPS is on battery. The event may be caused by a loose communication cable or, rarely, by a software conflict, such as an application inadvertently blocking PowerChute PLUS from monitoring the serial port while the UPS is on battery.

  RECOMMENDED ACTION: Run the command file UPS.CMD to either move or set the Cluster Groups offline. This script is described in Chapter 4, “The command file UPS.CMD” on page 67.

- **PowerChute PLUS Started**

  PowerChute PLUS UPS monitoring has been started.

  RECOMMENDED ACTION: None. After a shutdown, the cluster should be brought back online manually by the Administrator.

- **UPS Battery Is Discharged**

  The UPS is online, but its battery capacity is low. If power fails, PowerChute PLUS shuts down the system immediately.

  RECOMMENDED ACTION: Immediately notify the cluster administrator. Use the notify function that was implemented in PowerChute PLUS.

- **Lost Communication With UPS**

  PowerChute PLUS attempts to establish communication with the UPS and fails, or communication that was established is lost.

  RECOMMENDED ACTION: Immediately notify the cluster administrator. Use the notify function that was implemented in PowerChute PLUS.

- **UPS Output Overload**

  For an APC UPS, the equipment load on the UPS exceeds its rated load capacity. Reduce the load by unplugging some equipment from the UPS, and run a self-test.

  A Smart-UPS will sound an alarm when loads greater than 107% of its rating are applied for more than approximately four seconds. Sustained overloads greater in amplitude than 107% may cause the UPS's input circuit breaker to trip, depending on the level of overload and its duration. In this case, the UPS will shut down and not attempt to transfer to battery power in order to protect its internal circuitry. Note: an overload is detected and indicated independent of line voltage at 107% of full rated load for all models.

  When operating on-battery, the UPS will not attempt to support steady-state overloads and will shut down after approximately two to five seconds of their application. However, transient overloads applied while on-battery and lasting less than one second will be supported up to 150% of the UPS's load rating. In this case, the output voltage may not be within the specified regulation limits. The likelihood of the UPS shutting down while operating on-battery due to transient overload above this rating is increased as the battery becomes discharged during an extended power outage.

  RECOMMENDED ACTION: Immediately notify the cluster administrator.

- **Battery Needs Replacing**

  One or more UPS batteries are heavily discharged and can no longer hold a full charge. If utility power fails during this condition, an APC runs for less than half its normal run time.

RECOMMENDED ACTION: Immediately notify the cluster administrator. Use the notify function that was implemented in PowerChute PLUS.

2.4.1.5 Symmetra events

Apart from the events mentioned above, the Symmetra system features additional events that are specific to that UPS model only:

- **UPS On Bypass: Failure**

  The Symmetra UPS is on bypass due to a UPS failure.

  RECOMMENDED ACTION: Immediately notify the cluster administrator.

- **UPS Module Failed**

  One of the Symmetra power modules has failed.

  RECOMMENDED ACTION: Immediately notify the cluster administrator.

- **Main Intelligence Module Failed**

  The main intelligence module has failed.

  RECOMMENDED ACTION: Immediately notify the cluster administrator.

- **Redundant Intelligence Module Failed**

  The redundant intelligence module has failed.

  RECOMMENDED ACTION: Immediately notify the cluster administrator.

- **System Level Fan Failed**

  The Symmetra fan has failed.

  RECOMMENDED ACTION: Immediately notify the cluster administrator.

- **Bypass Contactor Failed**

  The bypass contactor has failed.

  RECOMMENDED ACTION: Immediately notify the cluster administrator.

- **Input Circuit Breaker Tripped**

  The input circuit breaker has tripped.

  RECOMMENDED ACTION: Immediately notify the cluster administrator.

2.4.1.6 PowerChute and UPS delays

Various delays for event actions or shutdown come into play when configuring PowerChute software. Figure 13 on page 23 explains the sequence in which the delays are deployed.

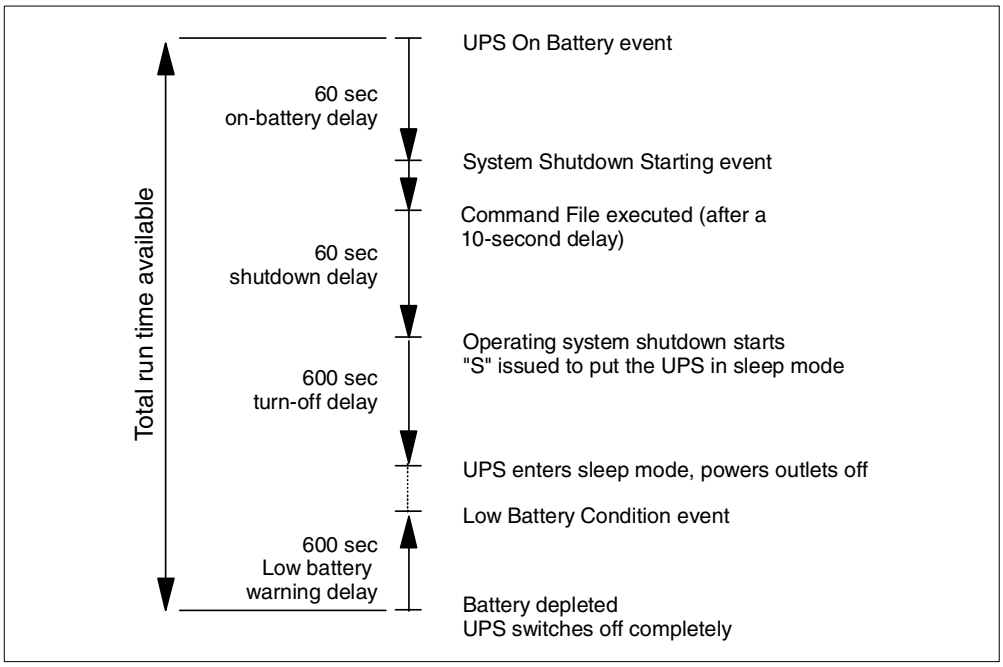


Figure 13. PowerChute PLUS event actions and UPS delays

2.4.2 PowerChute network shutdown

PowerChute network shutdown software provides graceful, unattended shutdown of multiple computer systems (up to 50) over the network. It communicates across the network with an APC UPS equipped with an AP9606 Web/SNMP Management Card. A Web browser can be used to quickly and easily configure individualized server shutdown settings.

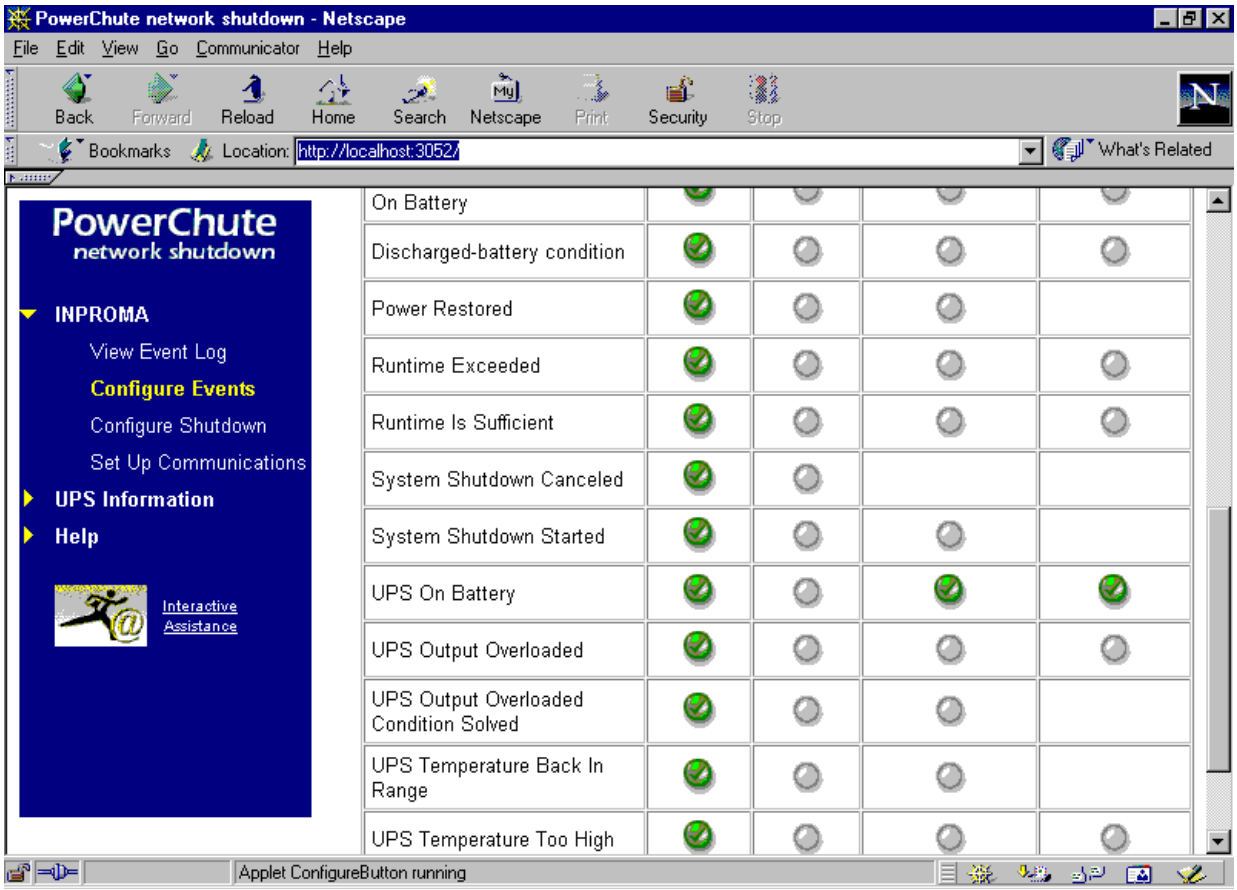


Figure 14. PowerChute Network shutdown Web interface

More information is available at:

`http://www.apcc.com/products/management/pc_networkshutdown.cfm`

2.4.3 Signaling cables

APC UPS will correctly communicate with the PowerChute monitoring software only when the correct APC cable is used. Using a standard RS232 cable will result in loss of communication between the UPS and the software. Table 9 shows which APC cable is required for your configuration. APC cables usually come in the box with the UPS and serve as the software license for the PowerChute software. Should you need longer cables than those provided, extension cables are available and can be ordered separately.

Table 9. APC communication cables

Part Number	Description	Color	Length	OS platforms
AP940-0024C	Smart signaling	Black	2 meters	Windows, OS/2, NetWare, UNIX (except for SGI, AS/400, VMS)
AP940-1524C	Smart signaling	Black	5 meters	Windows, OS/2, NetWare, UNIX (except for SGI, AS/400, VMS)
AP940-0020B	Simple signaling	Grey	2 meters	Windows, OS/2, NetWare

AP940-0023A Order # AP9823	Simple signaling	Grey	2 meters	UNIX (except True64, Digital, DEC/OSF, SGI Irix, HP-UX on 800 machines and AS/400)
AP940-0095A	Plug & play cable smart signaling	Grey	2 meters	Windows 95/98
AP940-0095B	Plug & play cable smart signaling	Grey	2 meters	Windows 95/98, NT, 2000
AP940-1500 Order # AP9815	Extension cable	Grey	5 meters	Only to be used in connection with a smart or simple signaling cable
AP9825	Extension cable	Grey	<100 meters	Isolated extension cable
AP940-0019	Simple signaling	Grey	2 meters	Macintosh
AP940-006A	Simple signaling	Grey	2 meters	15-pin male cable for AS/400
AP940-0031A	Simple signaling	Grey	2 meters	9-pin male cable for AS/400
AP940-0103	Null modem cable	Grey	2 meters	Configure Share-UPS/Masterswitch
AP940-0039	Simple signaling	Grey	2 meters	9-25pin for UNIX VMS
AP940-0049A	Smart signaling	Grey	2 meters	SGI Irix Indy or Indygo2 HW
AP940-1000A	signaling cable	Grey	3 meters	Triple chassis to UPS Redundant Switch to UPS1 + UPS2
AP940-0110A	Powerview cable	Grey	3 meters	Powerview to Symmetra cable

More information is available at:

`http://www.apcc.com/products/accessories/cable_kits.cfm`

2.5 Power plugs and connectors

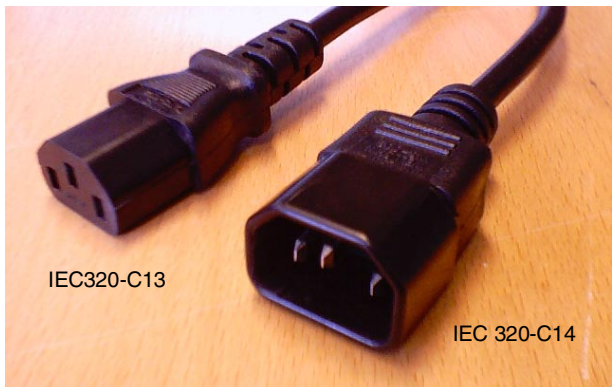


Figure 15. Cable C12

Figure 16. Cable D12

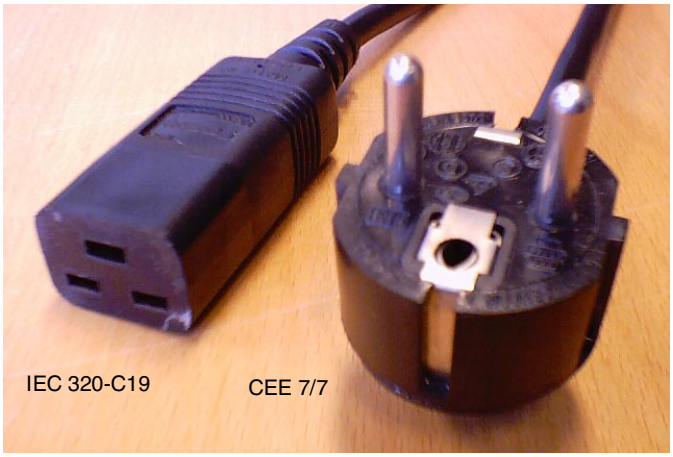


Figure 17. Cable

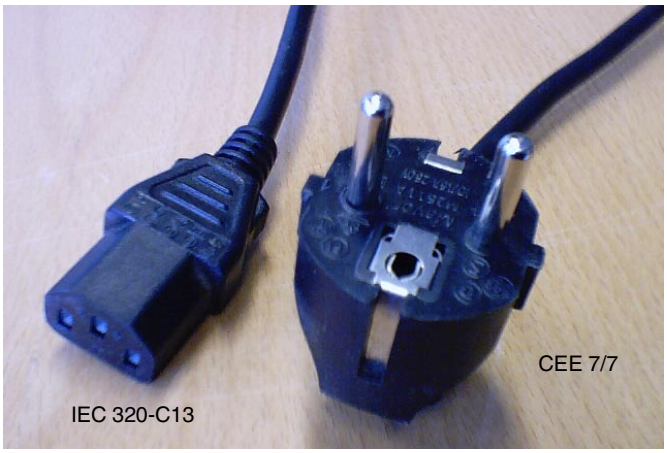


Figure 18. Cable

Chapter 3. UPS configurations for cluster

There are two different ways to use UPS units:

- Single power line: one UPS for both servers, controllers, and enclosures. This will be used in small cluster configurations or with a large UPS (Symmetra).
- Double power line: two UPS units, one UPS for each server, controller and enclosures are connected to both UPS units. This will be used in large data centers with two independent power lines.

In a complete solution, this would be combined with UPS software that utilizes the cluster API. Since such software does not exist at present, another solution is required. A simple command file UPS.CMD is sufficient, but works only for two-node clusters.

We recommend that the operating system of the cluster is installed in the English language. We developed the command file, UPS.CMD, with the English version of Microsoft Windows NT 4.0 Enterprise Edition. The messages may be different if any other language than English is installed. The command file depends on the exact spelling of English messages. For use with other languages, UPS.CMD has to be adapted.

Every time the command file UPS.CMD is used, it makes an output redirection into a log file LOG.TXT. This log file contains events related to the UPS.

As a test we used an MSCS solution with two IBM Netfinity 8500Rs (8681), an IBM Netfinity Fibre Channel RAID Controller Unit (3526) with six IBM Netfinity EXP15 (3520) storage expansion enclosures, and two IBM Netfinity Fibre Channel hubs (3523). We implemented this cluster with two redundant Fibre Channel loops. The computer name for the first Netfinity was NF8500L (Netfinity 8500 left), for the second Netfinity NF8500R (Netfinity 8500 right). On both nodes, Microsoft Windows NT 4.0 Enterprise Edition with Service Pack 5 was installed. The language of the operating system was English. Two virtual file servers (VFS) were defined as cluster resources. Each virtual file server had its own group with the names VFS_A and VFS_B. In each group we defined an IP address, a network name, a shared disk resource, and a file share.

3.1 General UPS configuration rules

Note: Our solution is based on the command file UPS.CMD. It is mandatory that the administrator adapt this file according to the cluster configuration. For details, see Chapter 4, “The command file UPS.CMD” on page 67.

Important

It is important to understand which actions the UPS performs when a power loss is detected. These issues are discussed in 3.1.1, “Timing of UPS actions” on page 28. Then we consider UPS capacity planning in 3.1.2, “UPS capacity planning” on page 29 and recovery in 3.1.3, “Recovery” on page 30.

3.1.1 Timing of UPS actions

Figure 19 shows the timing of UPS actions.

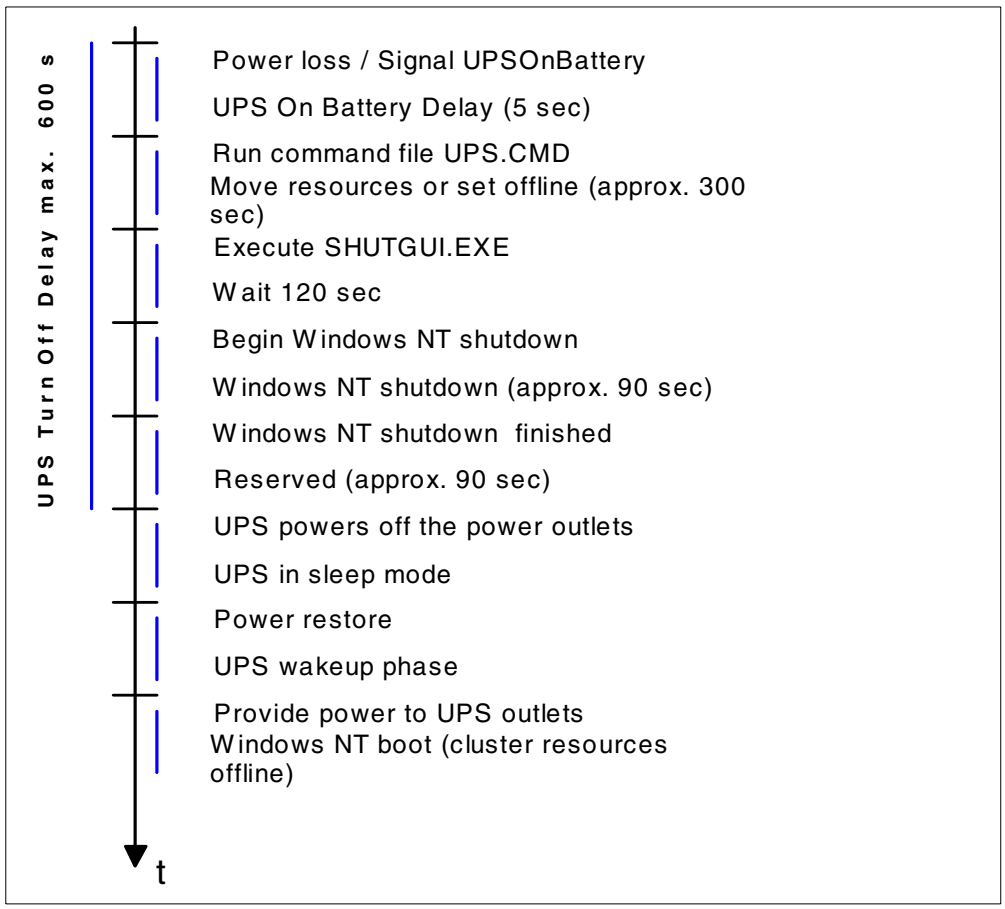

UPS Turn Off Delay max. 600 s
Power loss / Signal UPSOnBattery
UPS On Battery Delay (5 sec)
Run command file UPS.CMD
Move resources or set offline (approx. 300 sec)
Execute SHUTGUI.EXE
Wait 120 sec
Begin Windows NT shutdown
Windows NT shutdown (approx. 90 sec)
Windows NT shutdown finished
Reserved (approx. 90 sec)
UPS powers off the power outlets
UPS in sleep mode
Power restore
UPS wakeup phase
Provide power to UPS outlets
Windows NT boot (cluster resources offline)
t

Figure 19. Timing of UPS actions

1. When the UPS detects a power line failure, the signal UPSOnBattery is sent via signaling cables (or network) to the servers.
2. All further actions are delayed as defined by the UPS On Battery Delay. This delay filters short power outages so they do not shut down the server. We decided for a delay of 5 seconds to allow enough time for shutdown, but a longer delay may be useful in case of an accidental power plug removal of the UPS.
3. After the UPS On Battery Delay, actions defined in PowerChute PLUS for this event are performed. In our solution, the only action is to run the command file UPS.CMD.
   a. This command file analyzes the situation and handles cluster resources. The time of 300 seconds shown in Figure 19 means the time necessary to move or bring offline all application-related resources in the cluster (thus 300 seconds are an example only).
   b. After resource handling is completed, shutdown of the operating system is initiated by executing SHUTGUI.EXE.

4. Some commands in UPS.CMD were launched asynchronously. To allow such operations to complete, we added a delay as a SHUTGUI.EXE parameter. The value of 120 seconds is an example.
5. After this SHUTGUI.EXE delay, the operating system begins to shut down.
6. From our experience, a Windows NT 4.0 shutdown requires approximately 90 seconds. This depends on the number of remaining (non-clustered) services and applications.
7. Figure 19 shows a reserve interval of 90 seconds. We used this to get some flexibility in UPS capacity planning. If any of the time estimates above turned out to be too low (for example, an operating system shutdown takes longer than usual), then this reserved time may be used up.
8. The UPS powers off the power outlets and enters sleep mode (monitors input for reestablishment of power).
9. Some time later, the power is restored.
10. During the UPS wakeup phase, a certain level of recharge must be reached, and the UPS Wakeup Delay must be passed. Recharge level and delay can be configured by the administrator.
11. The UPS powers on the power outlets.
12. The servers begin to boot (except when Windows 2000 power management requires operator intervention). With our solution, application-related cluster resources are offline.

The time between steps 1 and 8 is limited by the UPS Turn Off Delay. This delay cannot be set to a value greater than 600 seconds. Thus the sum of all intervals shown in Figure 19 from step 1 to step 8 must not exceed 600 seconds.

3.1.2 UPS capacity planning

A UPS should have the capacity to manage a complete shutdown, even if the next power loss occurs shortly after reestablishing power. With a APC UPS, you can configure to which level the UPS must be charged before going online. Capacity calculation is based on the shutdown time. The UPS must be able to provide the total power workload for all components during a complete shutdown.

To get the minimum value for UPS run time, increase the estimated shutdown time by 10 percent. This takes into account that each battery loses capacity during its life.

We developed solutions for providing power via one power line see 3.2, “Single power line solutions” on page 31) or with exploiting power line redundancy (see 3.3, “Solutions with double power lines” on page 51). Depending on the solution you choose, one or two UPS units are needed. In the case of two units, the cluster’s power workload is distributed among them, so that each unit provides (in the ideal case) half of the total workload.

The electrical requirements are:

- An IBM Netfinity 8500R (8681) needs an electrical input in kilovolt-amperes (kVA) between approximately 0.5 kVA and 2.1 kVA from three power supplies. (Reference: *IBM Netfinity 8500R Hardware Maintenance Manual*.)

- The IBM Netfinity EXP15 storage expansion enclosure (3520) has an electrical input between approximately 0.06 kVA and 0.39 kVA from two power supplies. (Reference: *IBM Netfinity EXP15 Storage Expansion Unit Hardware Maintenance Manual*.)
- The electrical input of an IBM Fibre Channel RAID Unit (3526) is similar to an EXP15. (Reference: *IBM Netfinity Fibre Channel Hardware Maintenance Manual*.) The requirement of the IBM Fibre Channel Hub (3523) is approximately 0.2 kVA.

The electrical requirements depend on the configuration details of the devices (for example, the number of processor or PCI adapters). More adapters in an IBM Netfinity cause more electrical input. See `http://www.pc.ibm.com/support/` for details.

Additional components that have to be protected are network hubs or switches for client access to the cluster. Approximately 0.6 kVA are used in the following calculation.

Table 10. Total electrical input calculation

Component	Load	Number	Total
IBM Netfinity 8500R (8681)	2.1 kVA	2	4.2 kVA
IBM Netfinity Fibre Channel Hub (3523)	0.2 kVA	2	0.4 kVA
IBM Netfinity Fibre Channel RAID Unit (3526)	0.4 kVA	1	0.4 kVA
IBM Netfinity EXP15 Storage Expansion Unit (3520)	0.4 kVA	6	2.4 kVA
Network devices	0.6 kVA	1	0.6 kVA
			8.0 kVA

Our estimated shutdown time is 600 seconds. We added 60 seconds for risks such as battery aging, so for a solution with one UPS, we need a run time of 660 seconds with 8.0 kVA. For solutions with two UPS units, we need this run time with 4.0 kVA per unit.

As we see in Chapter 2, “APC hardware and software background” on page 3, only the APC Symmetra can provide an output of 8 kVA, leaving it the only choice for single UPS solutions. For example, in the Symmetra run time chart, look on the line “8 kVA” for a run time of at least 11 minutes. We see that we need four batteries.

For solutions with two UPS units, the SU5000 is a good choice to provide the output of 4 kVA. In the SU5000 run-time chart, notice that the estimated run time with 4 kVA is 8 minutes only. Therefore, in a production environment, the SU5000 is not recommended, and a larger UPS is needed. In our test environment we decided to use only one EXP15, giving us a run time of 11 minutes.

3.1.3 Recovery

We don’t recommend automatic recovery after a power failure for several reasons:

- In a data center, a lot of services relay on each other. For example, connection to a domain controller is needed to start the cluster service. This requires not only a PDC or BDC, but also stable network connections. Therefore, an

administrator intervention is useful to analyze the status of such components before starting production systems.

- There is a possibility that a resource operation might be aborted by an operating system shutdown. In case of an aborted operation, you cannot accurately predict the status of all resources at the moment of restart.
- With Windows 2000, the power management differs from Windows NT 4.0. At the end of an operating system shutdown, the machine is powered off automatically. When power is reestablished, the server must be switched on by pressing the power button.

3.2 Single power line solutions

The first thing to consider is that all electric power for the cluster is provided by one power line (one phase). This may be done via one or two UPS units. (More than two UPS units per two-node cluster should not be used because each server can configure or monitor only one UPS at a time.) The only possible scenario is the failure of this single power line causing shutdown of the cluster.

If one UPS is sufficient to supply the whole cluster, then the cabling schema is as shown in Figure 20.

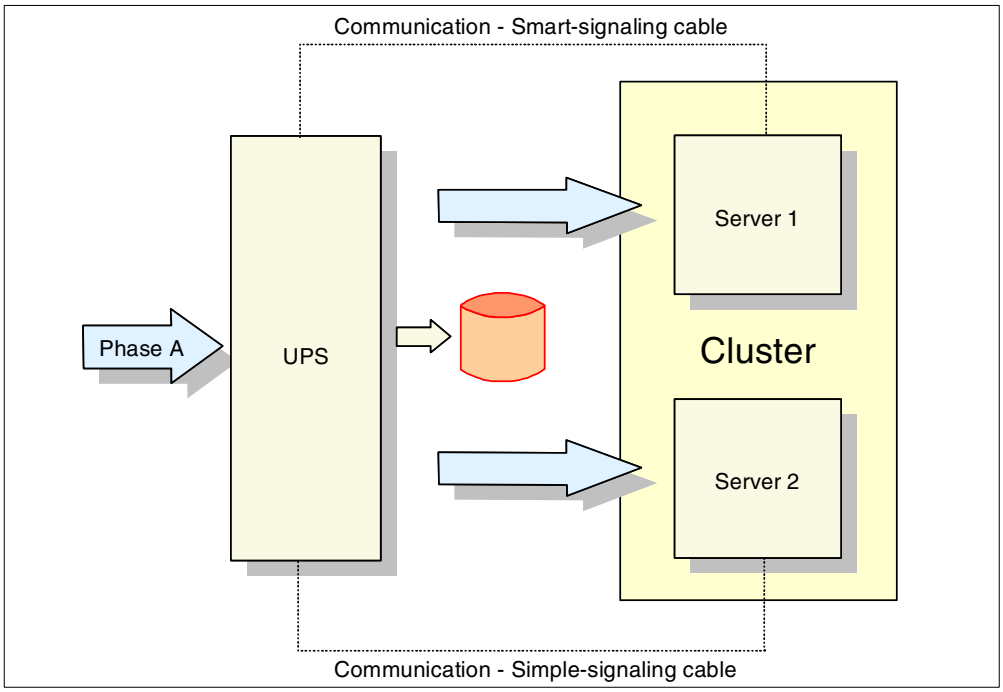


Figure 20. Single power line with one UPS

If two UPS units are necessary, then the power cabling for shared storage equipment needs special attention. As described in Storage power cabling on page 2, the wrong order of shared storage component failures may destroy RAID arrays. Thus we have to ensure that all storage components will lose power at the same moment. But the run time of the two UPS units is always different, even if they are of the same type, with the same load attached, and with the same shutdown parameters (because of aging effects).

We recommend that you attach each server to one UPS and then connect each shared storage device to both UPS units, as shown in Figure 21. In this way, timing problems are avoided, and the configuration can easily be extended to a solution with two separate power lines (discussed in 3.3, “Solutions with double power lines” on page 51).

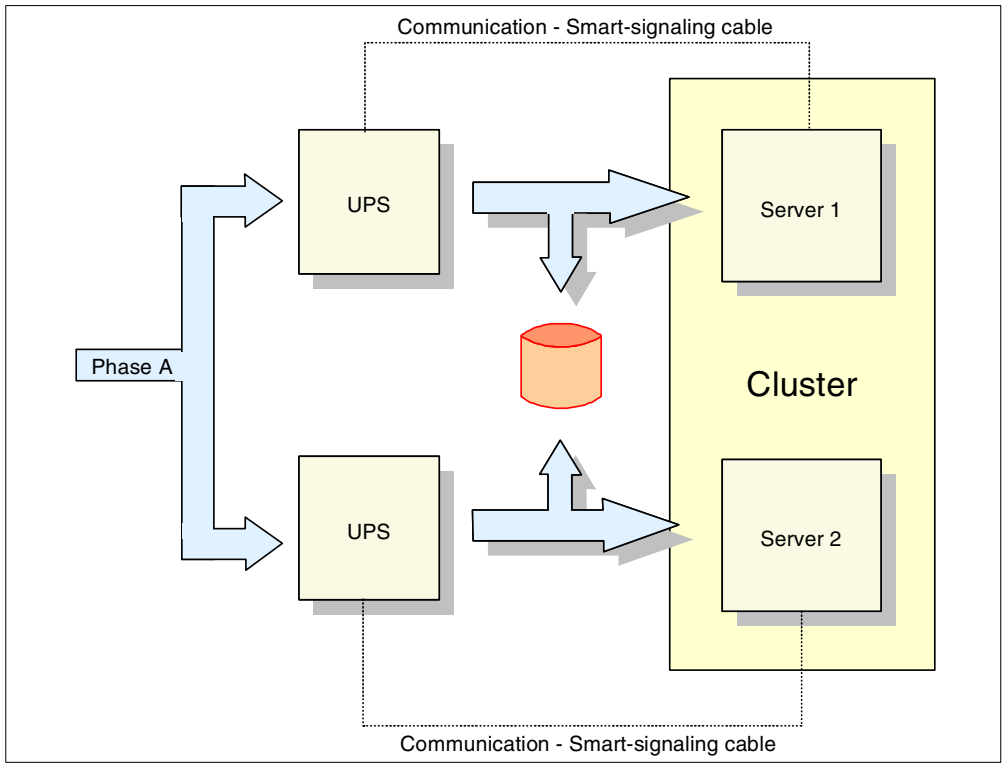


Figure 21. Single power line with two UPS units

In this paper, we restrict discussion of single power line solutions to the case with one UPS only. With two UPS units, the only difference is that both nodes use black smart-signaling cables. Thus both nodes would be installed identically (as described in 3.2.4, “Installing PowerChute PLUS on the node with a black serial cable” on page 35).

Most of the cluster-specific problems (from Chapter 1, “The problem” on page 1) don’t really exist with this approach; the server status is always the same for both machines because they have the same power source. For the same reason, there are no cases to consider for server power cabling. UPS monitoring is simple because one UPS can be monitored by more than one server. For storage protection and power cabling, the same arguments apply.

The problem of application shutdown is solved by our command file UPS.CMD. The command file is started by the Windows NT UPS service after a power failure. It sets the groups offline and shuts the server down.

This configuration provides a simple solution to all major problems. The disadvantages are a lack of power source redundancy and the need for a sufficiently large UPS.

3.2.1 Control flow in UPS.CMD

In the event of a UPS power loss, a delay (UPS On Battery Delay) is set. After this delay, the UPS service starts the UPS.CMD command file with the parameter SingleUPSOnBattery.

The main task of the command file UPS.CMD is to call CLUSTER.EXE. This is a Microsoft Cluster Server utility program installed during cluster setup that can be used to administer clusters from the command prompt. The CLUSTER.EXE parameters are described in the *Microsoft Cluster Server Administrator's Guide*. We use this utility for two purposes:

- The local cluster node is set to Paused. (The other node is also paused because the same script is running there.) Pausing a node means that existing groups and resources stay online, but groups and resources cannot be brought online on this node. In this way, we ensure that a resource brought offline will not be restarted for any reason. Also the cluster node status PAUSED is an indicator for administrators that the command file takes control.
- Groups that are currently located on this node are brought offline. Again, the same script is running on the other node and all resources (except quorum disk and Cluster Group) are handled. The quorum disk cannot be brought offline. The Cluster Group contains the cluster name and the IP address that must remain available for executing `CLUSTER.EXE` commands.

Details of the command file UPS.CMD are discussed in Chapter 4, "The command file UPS.CMD" on page 67.

Finally the OS will be shut down. After the period specified in UPS Turn Off Delay, the servers will be powered off.

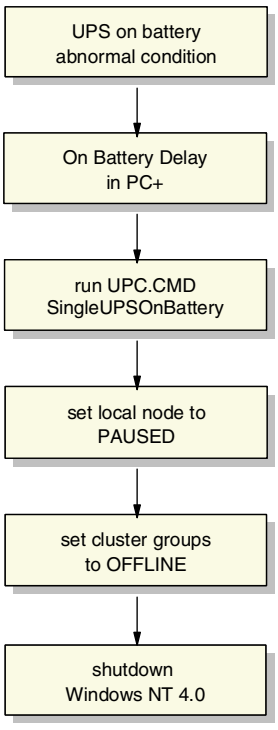


Figure 22. Single UPS flow chart

The operating system shutdown is started from the command file, not by using the PowerChute PLUS Shut Down Server action. When using this action, the server would be stopped after a maximum delay of 300 seconds. Since the time necessary to take a cluster resource offline varies, 300 seconds might be too short. Therefore, the script utilizes the SHUTGUI.EXE tool from the Microsoft Windows NT Resource Kit CD.

3.2.2 Example configuration with a single UPS

In our example, we use only one UPS, an APC Symmetra Power Array. It has an electrical output of 16.0 kVA. Our cluster requires an overall electrical input of 8.0 kVA. For example, in Table 7 on page 13 you can see that a Symmetra with 10 batteries has a run time of 53 minutes. The run time is dependent on the number of installed batteries and the load.

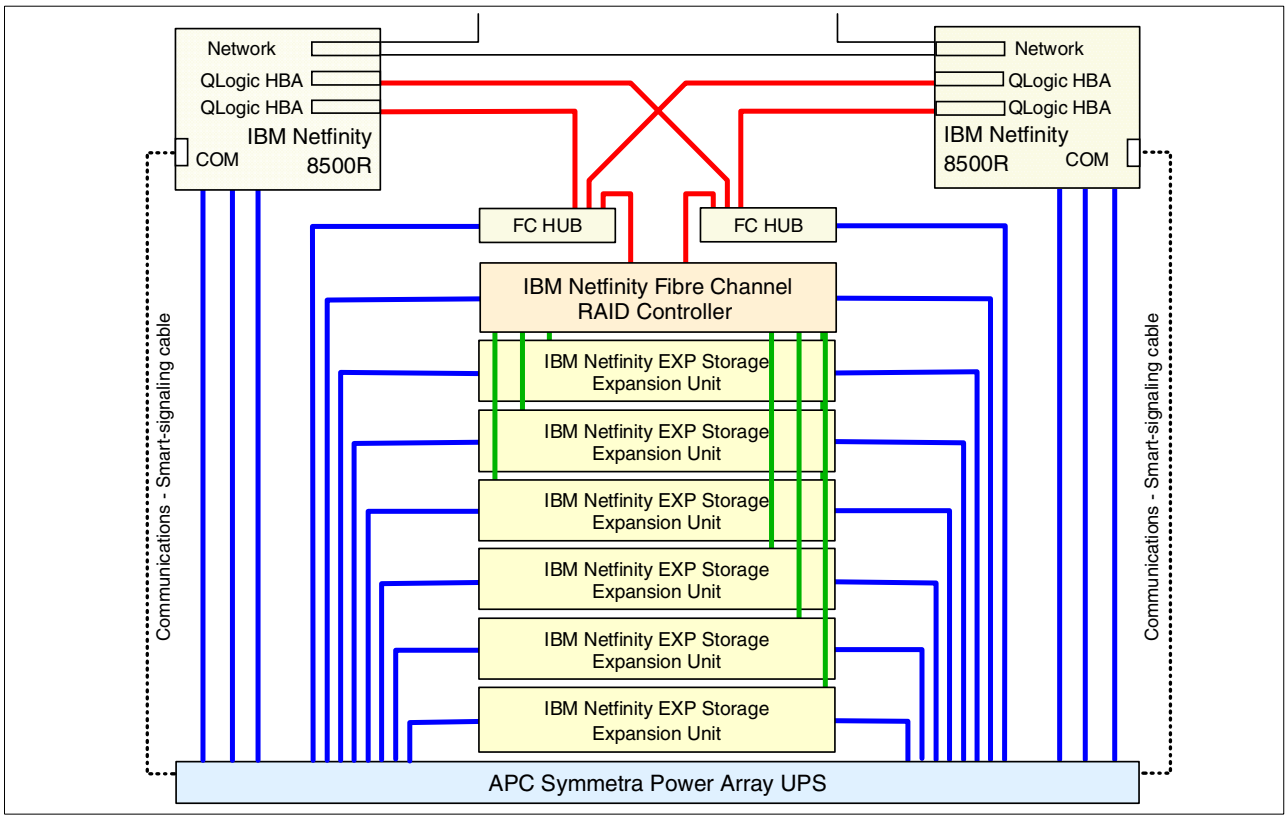


Figure 23. Single UPS cabling diagram

All power supplies of each Netfinity server are connected to the APC Symmetra Power Array, as well as the power supplies of the RAID controller, the enclosures, and the hubs. One server is connected to the UPS via a black serial cable (940-0024C). The second server is connected to the UPS Interface Expander Card via a grey serial cable (940-0020B).

The left node is named NF8500L, the right node NF8500R.

3.2.3 Preparing both nodes

To implement our solution, additional files are necessary, as described below. The configuration of PowerChute PLUS is shown in 3.2.4, “Installing PowerChute

PLUS on the node with a black serial cable" on page 35 and 3.2.6, "Installing PowerChute PLUS on the node with a grey serial cable" on page 44.

1. Create a new directory C:\UPS_CMD.
2. Create the command file UPS.CMD in C:\UPS_CMD (you can find the content of the file in Appendix B, "UPS.CMD" on page 77 or download it from `http://www.redbooks.ibm.com/`).
3. Copy the file SHUTGUI.EXE from the Windows NT Resource Kit CD to C:\UPS_CMD.

As result, you should have a directory similar to Figure 24 on page 35.

```
C:\>tree ups_cmd /f
Directory PATH listing for volume NTWKS
Volume serial number is 0012FC94 166F:1BD3
C:\UPS_CMD
    ups.cmd
    shutgui.exe

No subdirectories exist

C:\>
```

Figure 24. Directory view

3.2.4 Installing PowerChute PLUS on the node with a black serial cable

In 2.4.3, "Signaling cables" on page 24 the differences between black and grey cables are explained.

1. Install PowerChute PLUS 5.2 for Windows NT 4.0. You can download PowerChute PLUS from:

   `http://www.apcc.com/tools/download/`

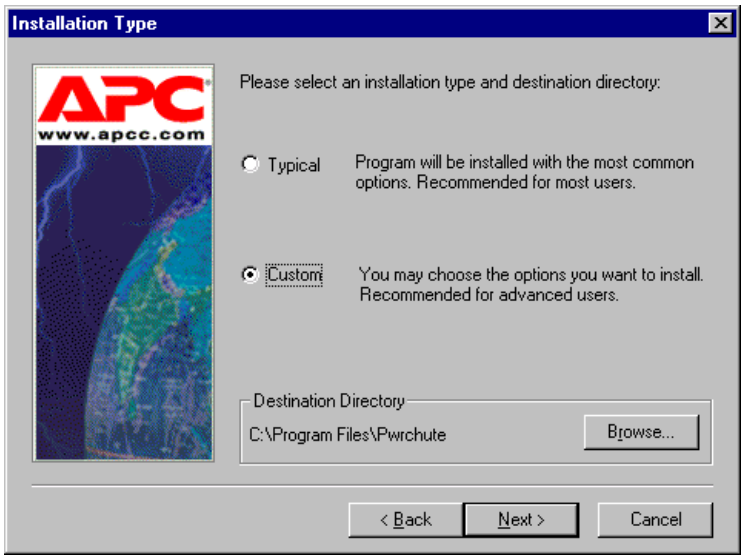


Figure 25. Install PowerChute PLUS - Choose type of installation

2. Select the **Custom** option and click **Next.** This displays Figure 26.

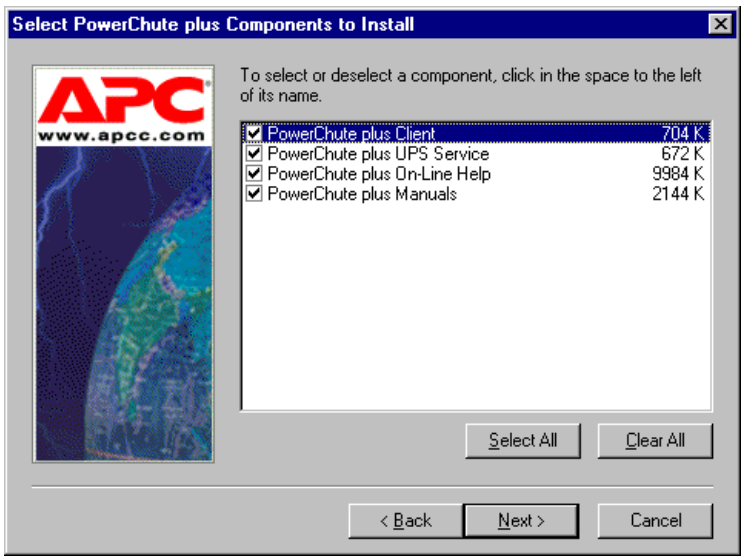

Select PowerChute plus Components to Install
www.apcc.com
To select or deselect a component, click in the space to the left of its name.
PowerChute plus Client 704 K
PowerChute plus UPS Service 672 K
PowerChute plus On-Line Help 9984 K
PowerChute plus Manuals 2144 K
Select All
Clear All
< Back
Next >
Cancel

Figure 26. Install PowerChute PLUS — select components

3. Select the boxes to install the components you wish to install. Select **PowerChute PLUS Client** and **PowerChute PLUS UPS Service**. The other components are optional. Click **Next** to display the Select Components window.

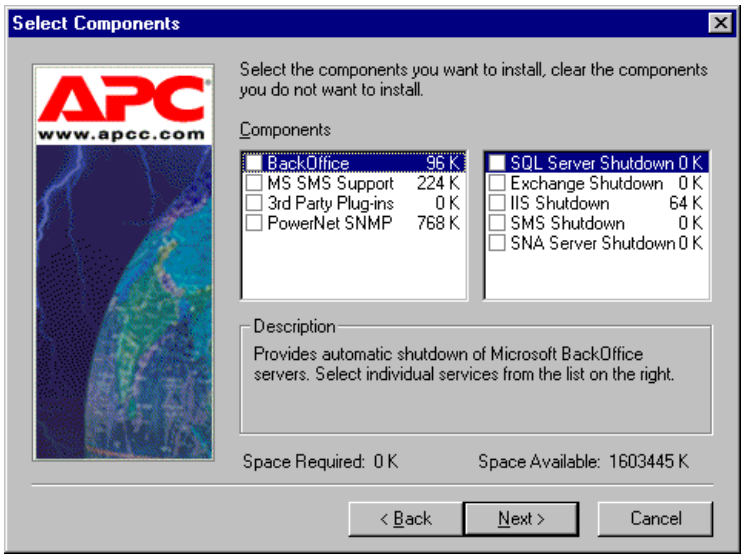

Select Components
www.apcc.com
Select the components you want to install, clear the components you do not want to install.
Components
BackOffice 96 K
MS SMS Support 224 K
3rd Party Plug-ins 0 K
PowerNet SNMP 768 K
SQL Server Shutdown 0 K
Exchange Shutdown 0 K
IIS Shutdown 64 K
SMS Shutdown 0 K
SNA Server Shutdown 0 K
Description
Provides automatic shutdown of Microsoft BackOffice servers. Select individual services from the list on the right.
Space Required: 0 K
Space Available: 1603445 K
< Back
Next >
Cancel

Figure 27. Install PowerChute PLUS — automatic shutdown components

4. Do not check any boxes of these components for automatic application shutdown. Click **Next**.

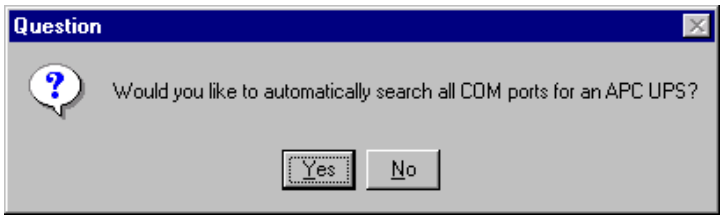


Figure 28. Install PowerChute PLUS — automatically detect UPS

5. The window shown in Figure 28 will be displayed. First, make sure that the smart-signaling cable is connected to the PC interface port of the UPS and to the serial COM port of the server. The smart-signaling cable is a black cable with the part number 940-0024C (a short cable) or 940-1524C (a longer cable).
6. Click the **Yes** button to automatically detect the UPS. The UPS will be found by the installation program, and Figure 29 will be displayed.

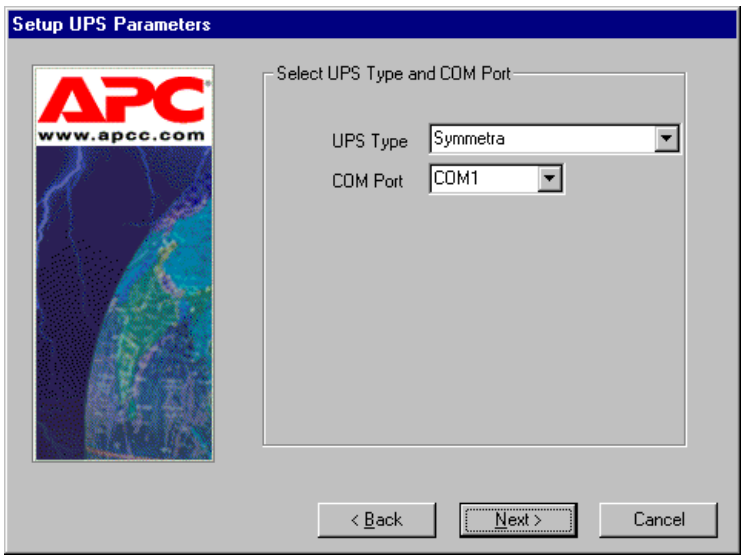


Figure 29. Install PowerChute PLUS — automatically detect the UPS

7. Your UPS should be discovered correctly. If not, you can select the UPS type and COM port manually from the pull-down menus. Click **Next** and Figure 30 will be displayed.

.

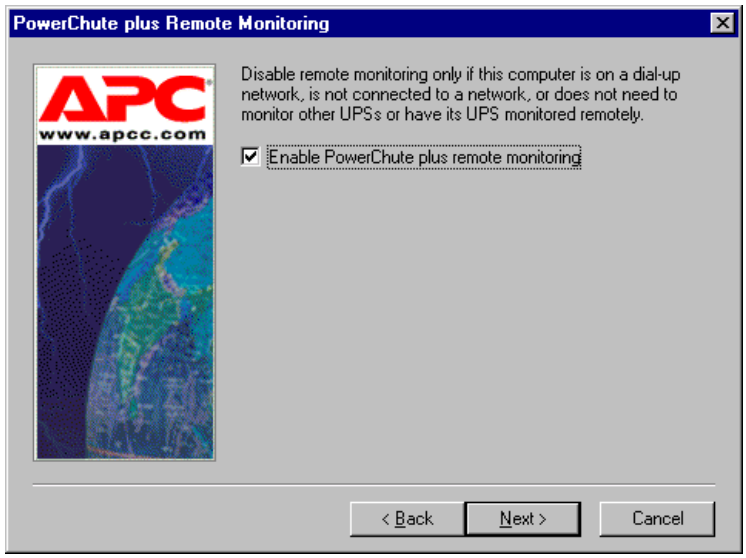

PowerChute plus Remote Monitoring
APC
www.apcc.com
Disable remote monitoring only if this computer is on a dial-up network, is not connected to a network, or does not need to monitor other UPSs or have its UPS monitored remotely.
Enable PowerChute plus remote monitoring
< Back
Next >
Cancel

Figure 30. Install PowerChute PLUS — remote monitoring

8. In this window select the box to enable the PowerChute PLUS remote monitoring function. For details see the PowerChute PLUS documentation.
9. Finish the installation by clicking **Next**. If you wish, you can now register your hardware and software with APC.

3.2.5 Configuring PowerChute PLUS on the node with a black serial cable

Now we configure the time intervals as shown in Figure 19 on page 28, and we define the actions according to the events described in 2.4.1.3, “PowerChute events” on page 19.

1. Start PowerChute PLUS. You see a window (Figure 31) with all servers in the same IP subnet segment where the PowerChute PLUS software is installed.

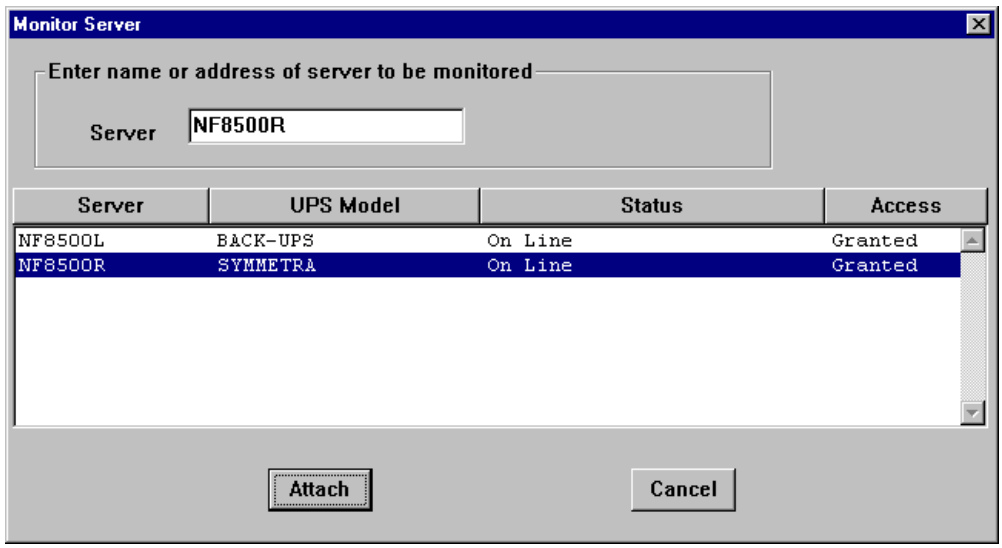


Figure 31. PowerChute PLUS — monitor server

2. Select your server. In our scenario, the second node is the NF8500R with the black serial cable. Click the **Attach** button, which will display the PowerChute PLUS main window shown in Figure 32.

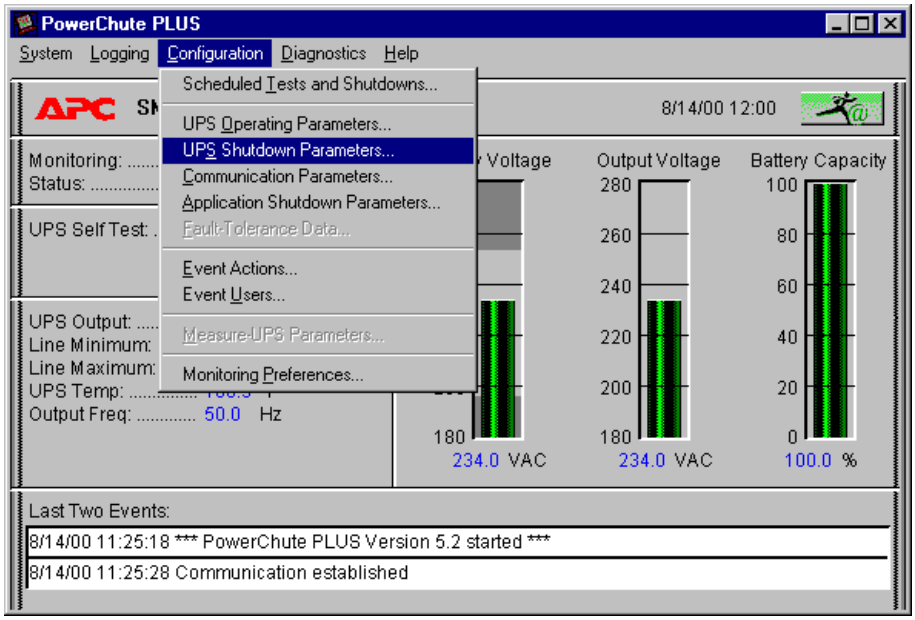


Figure 32. PowerChute PLUS — main window

3. In the PowerChute PLUS main window, select **Configuration > UPS Shutdown Parameters**. Figure 33 will be displayed.

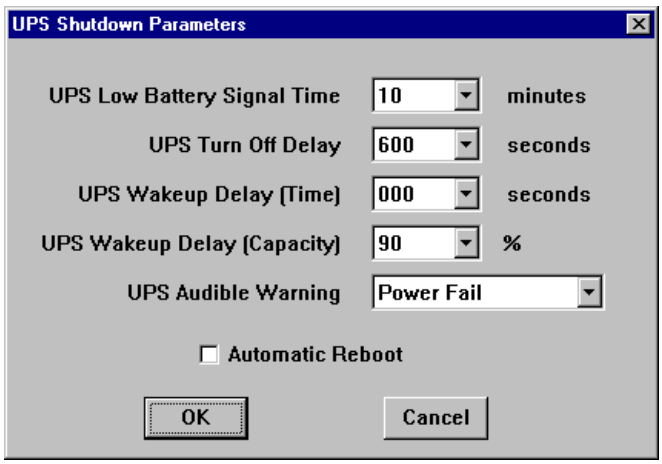


Figure 33. UPS Shutdown Parameters window

4. In the UPS Shutdown Parameters window, enter the following parameters:
   – **UPS Low Battery Signal Time**: This condition will occur if the battery is very old and the UPS can supply power for a short period only (thus immediate actions are required). It is the minimum number of minutes of battery run time that the UPS needs to perform the essential tasks of a safe system shutdown. Possible values are 2, 5, 7, and 10 minutes. We recommend 10 minutes to get enough time for shutdown.

– **UPS Turn Off Delay**: This period of time begins at power loss. After this interval, the UPS turns off its output power (independent of any shutdown completion). If line voltage returns during this period, turning off output power is canceled (again independent of any shutdown operations in progress). Possible delay values are 20, 180, 300, and 600 seconds. We recommend that you set the value as estimated in the time line (Figure 19 on page 28).

– **UPS Wakeup Delay (Time)**: This is the time that the UPS must be connected to a functioning power line before the attached systems can be powered up. Possible delay values are 0, 60, 180, and 300 seconds. Again, we recommend the maximum value of 300 seconds (to avoid system boot in situations with short-time power return only). Additionally, a percentage of full capacity for recharge may be specified as UPS Wakeup Delay (Capacity).

Once you have set the parameters, click the **OK** button.

5. In the PowerChute PLUS main window (shown in Figure 32 on page 39), select **Configuration > Application Shutdown Parameters**. Figure 34 will be displayed.

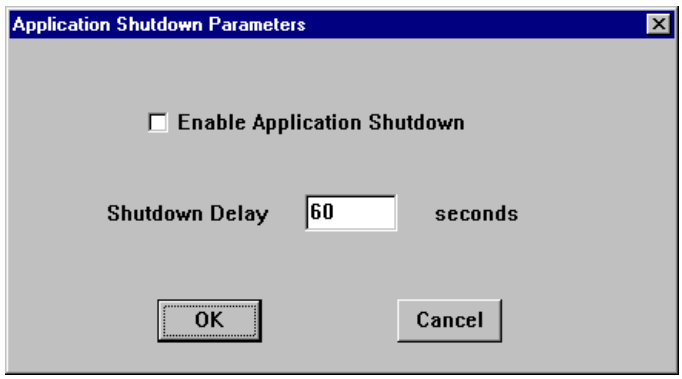


Figure 34. Single UPS application Shutdown Parameters window

6. Disable the application shutdown (because this will be handled by the command file UPS.CMD) and click the **OK** button.
7. In the PowerChute PLUS main window (shown in Figure 32 on page 39), select **Configuration > Event Actions**. Figure 35 will be displayed.

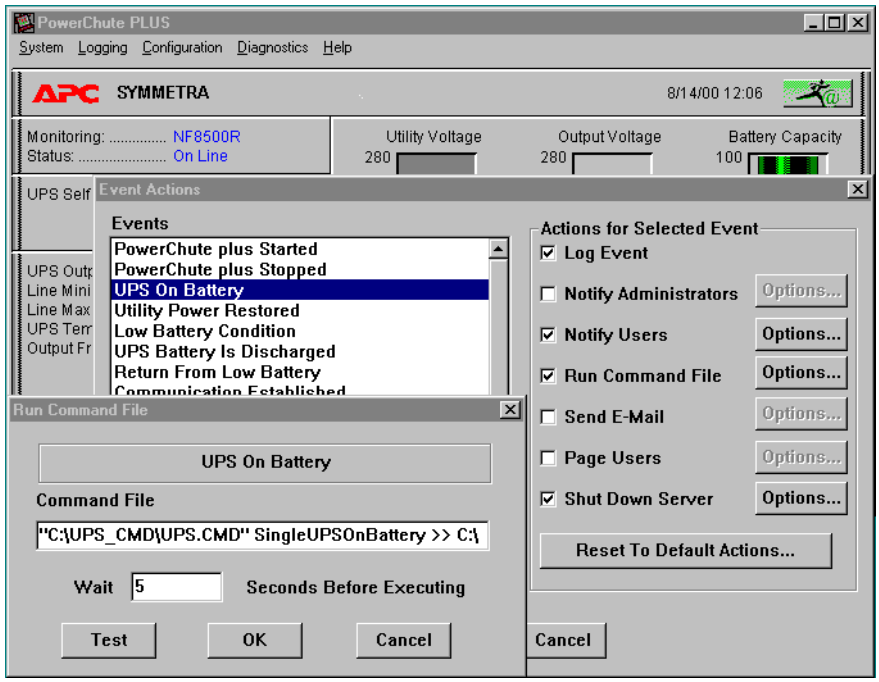


Figure 35. Single UPS Run Command File — UPS On Battery

8. In the Event Actions window, select **UPS On Battery**.
   a. Select the **Run Command File** checkbox and click **Options.** In the pop-up window, insert the following in the Command File field:

      "`C:\UPS_CMD\UPS.CMD`**"** `SingleUPSOnBattery >> C:\UPS_CMD\LOG.TXT`

   b. Set the Wait value to 5 seconds. This wait time (UPS On Battery Delay in Figure 19 on page 28) before executing the command file prevents short power failures from shutting down the cluster. Click the **OK** button, to apply your choices.

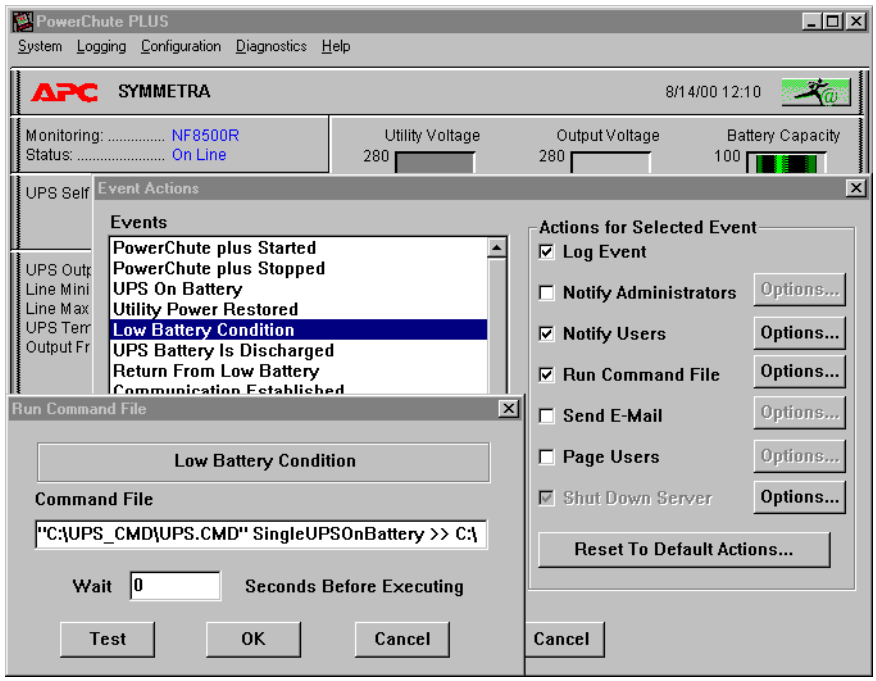


Figure 36. Single UPS Run Command File — Low Battery Condition

9. Now select **Low Battery Condition** in the Event Actions window.
   a. Check **Run Command File** the checkbox and click **Options**.
   b. In the pop-up window, insert the following in the Command File field:

      "`C:\UPS_CMD\UPS.CMD`**"** `SingleUPSOnBattery >> C:\UPS_CMD\LOG.TXT`

   c. Set the Wait value to 0 seconds. A low battery condition means that the UPS can only supply the systems for a short period and immediate actions must take place. This wait time forces immediate execution of the command file when a low battery condition occurs. Click the **OK** button to apply your choices.

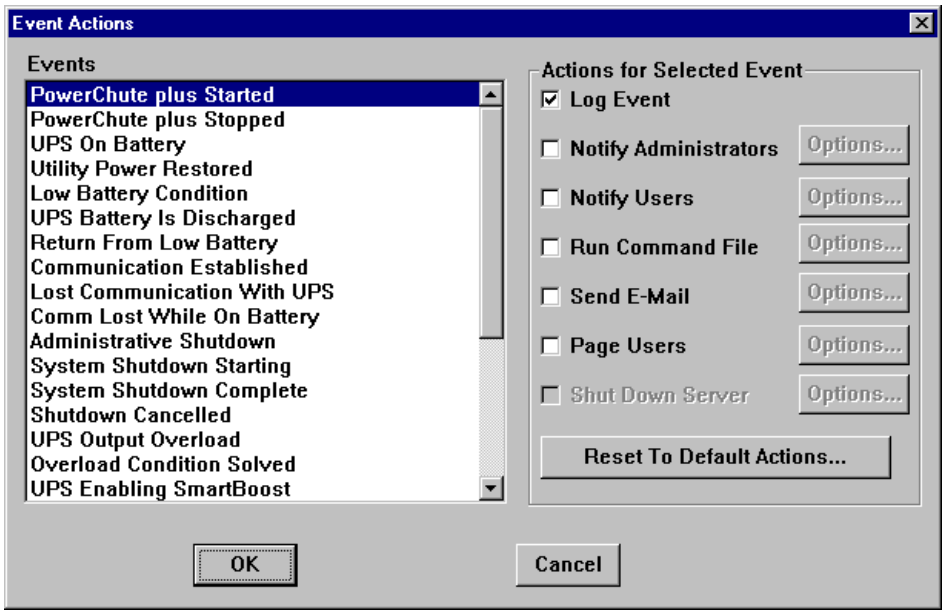


Figure 37. Single UPS Event Actions

10. In the Event Actions window, select **PowerChute PLUS Started**.

    Clear the check in the Run Command File checkbox.

    We strongly recommend that you do not start the cluster automatically. An administrator has to evaluate the situation and take the required measurements. Besides, it is mandatory to start the systems in a data center in a certain order (PDC, BDC, databases, etc.). Usually the MSCS is the last component to start.

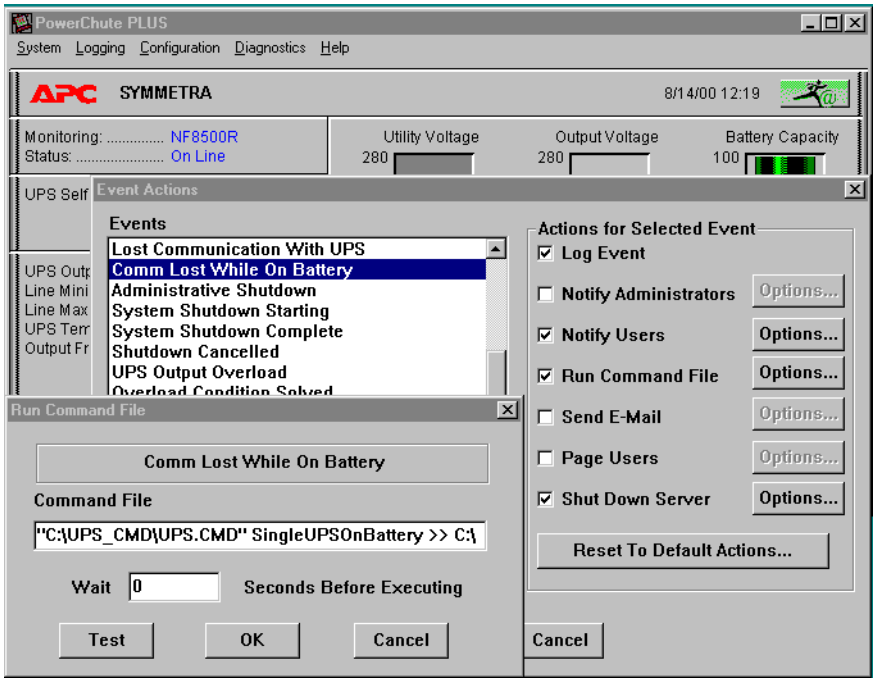


Figure 38. Single UPS Run Command File — Comm Lost While On Battery

11. In the Event Actions window shown in Figure 38, select **Comm Lost While On Battery**.

    a. Select the **Run Command File** checkbox and click **Options**.

    b. In the pop-up window, insert the following in the Command File field:

    ```
    "C:\UPS_CMD\UPS.CMD" SingleUPSOnBattery >> C:\UPS_CMD\LOG.TXT
    ```

    c. Set the Wait value to 0 seconds. If the UPS is on battery and the communication is lost, an immediate action is required because the state and the run time of the UPS are unknown.

3.2.6 Installing PowerChute PLUS on the node with a grey serial cable

1. Install PowerChute PLUS 5.2 for Microsoft Windows NT 4.0. You can download PowerChute PLUS from:

   ```
   http://www.apcc.com/tools/download/
   ```

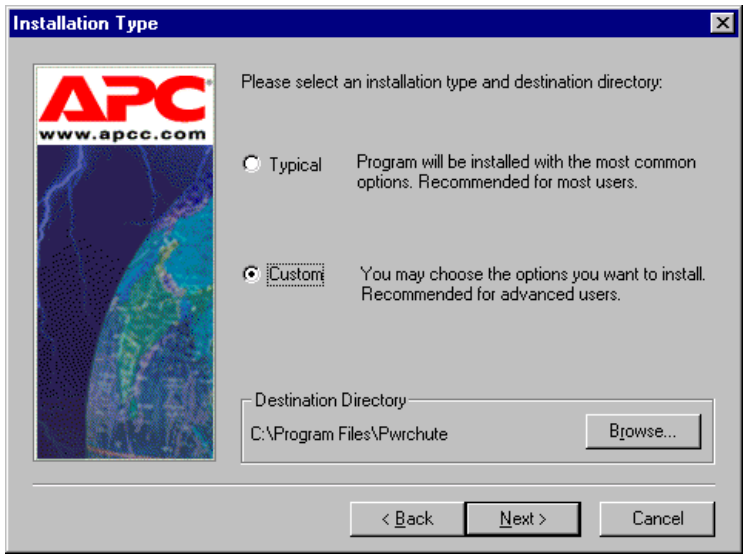


Figure 39. Install PowerChute PLUS — Choose Type of Installation

2. Select the **Custom** option and click **Next.** This displays Figure 40.

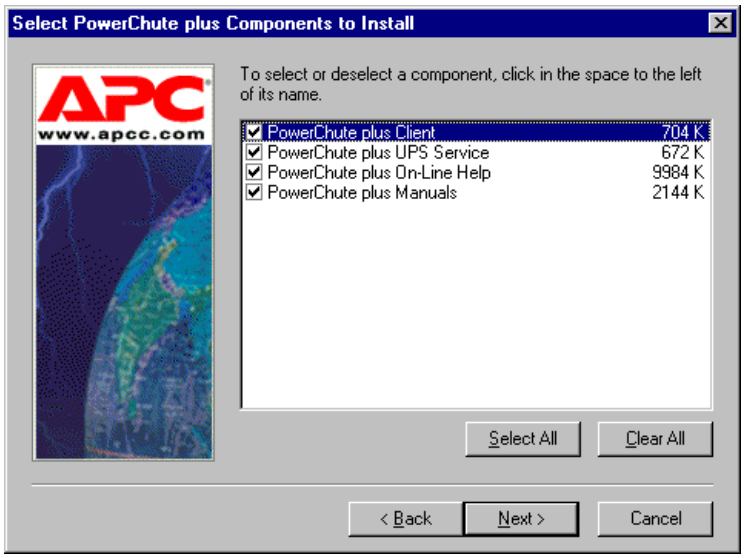

Select PowerChute plus Components to Install
www.apcc.com
To select or deselect a component, click in the space to the left of its name.
PowerChute plus Client 704 K
PowerChute plus UPS Service 672 K
PowerChute plus On-Line Help 9984 K
PowerChute plus Manuals 2144 K
Select All
Clear All
< Back
Next >
Cancel

Figure 40. Install PowerChute PLUS — Select Components to Install

3. Select the boxes of the components you wish to install. Select **PowerChute PLUS Client** and **PowerChute PLUS UPS Service**. The other components are optional. Click **Next** to display the Select Components window.

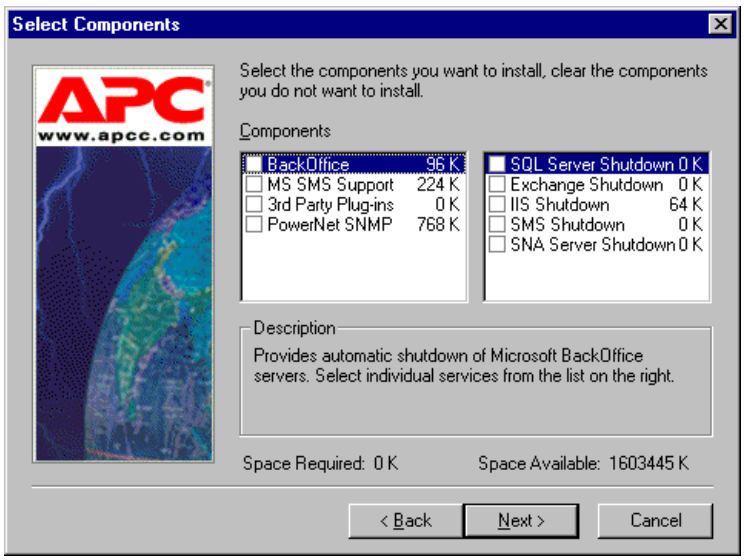

Select Components
www.apcc.com
Select the components you want to install, clear the components you do not want to install.
Components
BackOffice 96 K
MS SMS Support 224 K
3rd Party Plug-ins 0 K
PowerNet SNMP 768 K
SQL Server Shutdown 0 K
Exchange Shutdown 0 K
IIS Shutdown 64 K
SMS Shutdown 0 K
SNA Server Shutdown 0 K
Description
Provides automatic shutdown of Microsoft BackOffice servers. Select individual services from the list on the right.
Space Required: 0 K
Space Available: 1603445 K
< Back
Next >
Cancel

Figure 41. Install PowerChute PLUS — Select Next Components

4. Do not check any boxes of these components for automatic application shutdown. Click **Next**.
5. The window shown in Figure 42 will be displayed. First make sure that an Interface Expander Card is installed in the Symmetra Power Array.
6. Make sure that the simple-signaling cable is connected to a basic monitoring port of the Interface Expander Card in the Symmetra Power Array and to the serial COM port of the server. The simple-signaling cable is a grey cable with the part number 940-0020B.

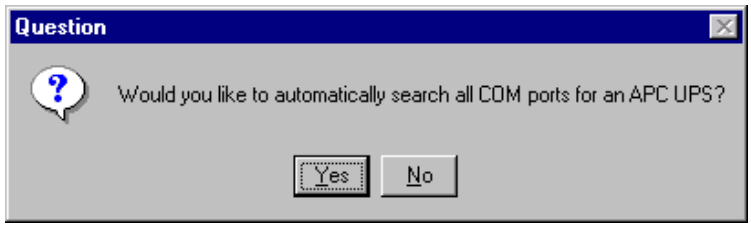


Figure 42. Install PowerChute PLUS — automatically detect UPS parameters

7. The UPS will not be found by the installation program because auto detection via the simple-signaling cable is not possible. Thus click the **No** button. Figure 43 will be displayed.

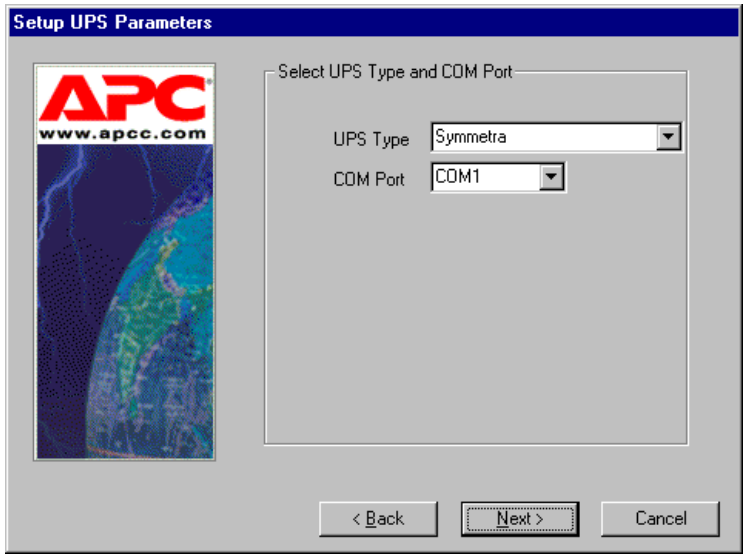


Figure 43. Select UPS Type and COM Port window

8. Select **Back-UPS** as the UPS type and the COM port that is connected to the UPS with the grey serial cable (part number 940-0020B). Click the **Next** button and Figure 44 will be displayed.

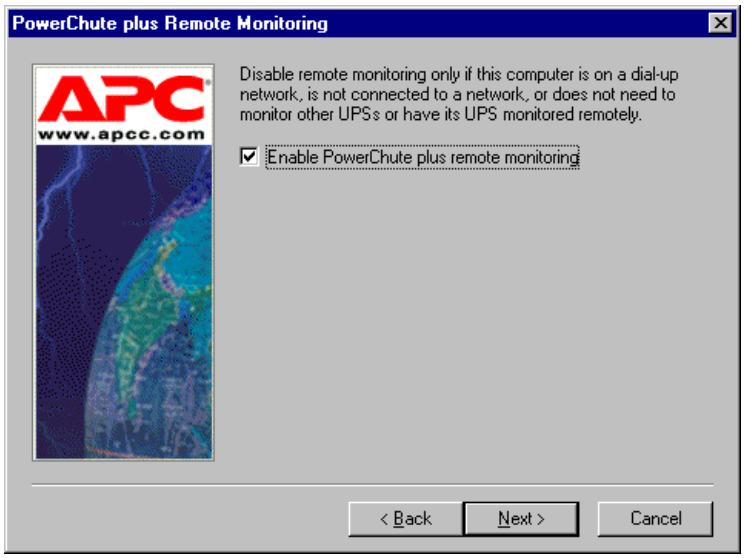

PowerChute plus Remote Monitoring
www.apcc.com
Disable remote monitoring only if this computer is on a dial-up network, is not connected to a network, or does not need to monitor other UPSs or have its UPS monitored remotely.
Enable PowerChute plus remote monitoring
< Back
Next >
Cancel

Figure 44. Disable remote monitoring

9. In this window, select the box to enable the PowerChute PLUS remote monitoring function. For details see the PowerChute PLUS documentation.
10. Finish the installation by clicking the **Next** button. If you wish, you can now register your hardware and software with APC.

3.2.7 Configuring PowerChute PLUS on the node with a grey serial cable

Now we configure the time intervals as shown in Figure 19 on page 28, and we define the actions according to the events described in 2.4.1.3, “PowerChute events” on page 19.

1. Start PowerChute PLUS. You see a window (shown in Figure 45) with all servers in the same IP subnet segment where the PowerChute PLUS software is installed.

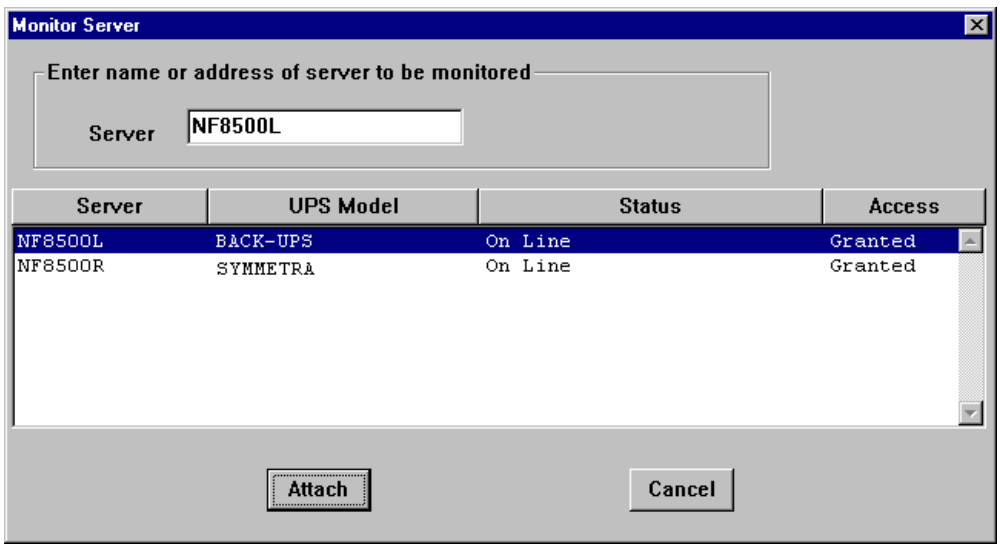


Figure 45. Single UPS Monitor Server

2. Select your server. In our scenario, the first node is the NF8500L with the grey serial cable. Click the **Attach** button, which will display the main window, shown in Figure 46.

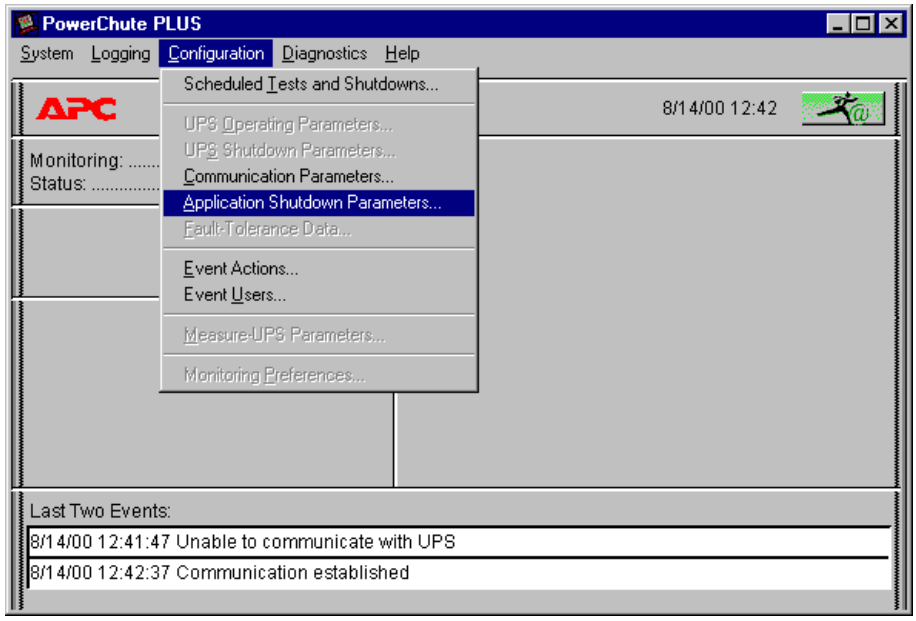


Figure 46. PowerChute PLUS — main window

3. In the PowerChute PLUS main window, select **Configuration > Application Shutdown Parameters**. Figure 47 will be displayed.

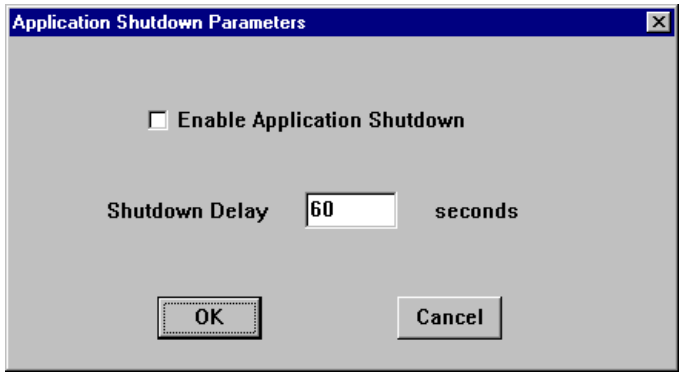


Figure 47. Single UPS Application Shutdown Parameters

4. In this window, clear the Enable Application Shutdown checkbox to disable the application shutdown (because this will be handled by the command file UPS.CMD) and click the **OK** button.
5. In the PowerChute PLUS main window (Figure 46), now select **Configuration > Event Actions**. Figure 48 will be displayed.

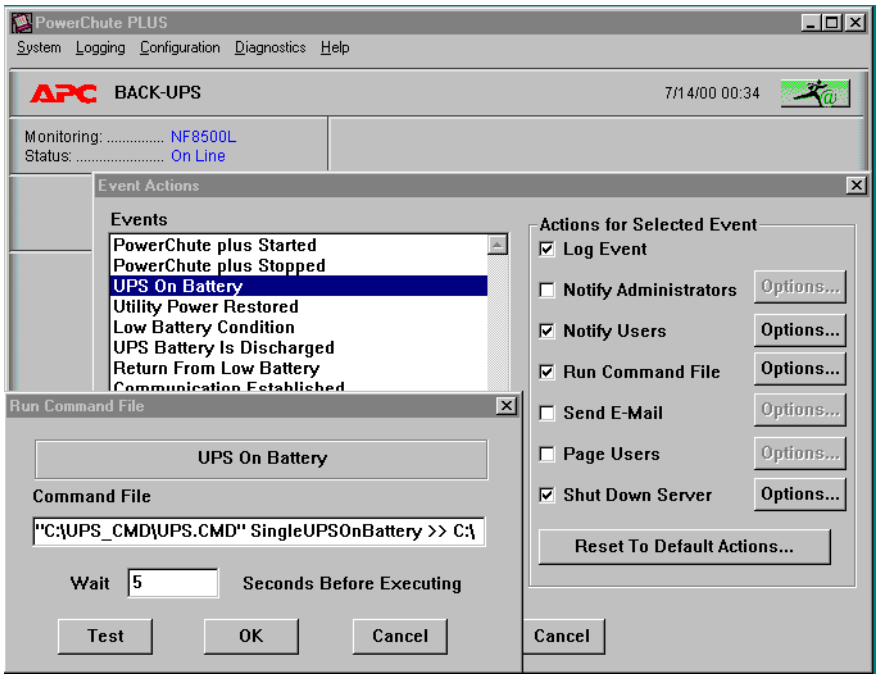


Figure 48. Single UPS Run Command File — UPS On Battery

6. In the Event Actions window, select **UPS On Battery**.

   a. Select the **Run Command File** checkbox and click **Options.** In the pop-up window, insert the following in the Command File field:

      "`C:\UPS_CMD\UPS.CMD`**"** `SingleUPSOnBattery >> C:\UPS_CMD\LOG.TXT`

   b. Set the Wait value to 5 seconds. This wait time (UPS On Battery Delay in Figure 19 on page 28) before executing the command file prevents short power failures from shutting down the cluster. Click the **OK** button to apply your choices.

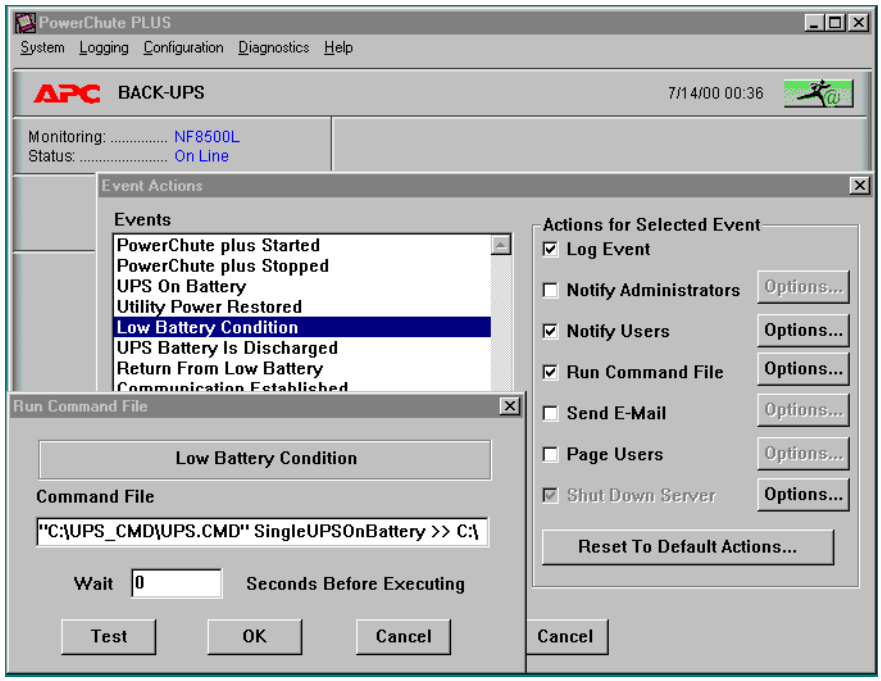


Figure 49. Single UPS Run Command File — Low Battery Condition

7. In the Event Actions window, select **Low Battery Condition**.
   a. Select the **Run Command File** checkbox and click **Options**.
   b. In the pop-up window, enter the following in the Command File field:

      `"C:\UPS_CMD\UPS.CMD" SingleUPSOnBattery >> C:\UPS_CMD\LOG.TXT`

   c. Set **Wait** to 0 seconds. A low battery condition means that the UPS can supply the systems for a short period only and immediate actions must take place. This wait time forces immediate execution of the command file when a low battery condition occurs. Click the **OK** button to apply your choices.

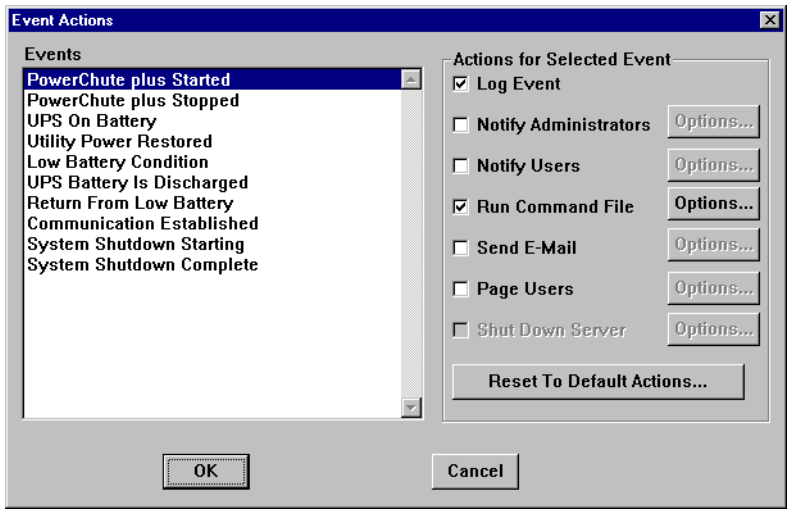


Figure 50. Single UPS Event Actions

8. Select **PowerChute PLUS Started**.

   Clear the **Run Command File** checkbox.

   We strongly recommend that you do not start the cluster automatically. An administrator has to evaluate the situation and take the required measurements. Besides, it is mandatory to start the systems in a data center in a certain order (PDC, BDC, databases, etc.). Usually the MSCS is the last component to start.

3.3 Solutions with double power lines

Now let's consider the case when electric power for the cluster is provided by two independent power lines, which happens if:

- The data center exploits two power phases.
- The cluster is a long-distance configuration in two different data centers.

In contrast to the case of a single power line, now there are three possible failure scenarios:

1. One power line is working properly and the other one is failing.
2. Both power lines are failing at the same time.
3. One power line is failing and the second power line fails a short period of time later (when actions triggered by the first failure are not completed).

There are several possibilities for power cabling, but in all cases, power cabling for shared storage equipment needs special attention. As described in Storage power cabling on page 2, the wrong order of shared storage component failures may destroy RAID arrays. Thus we have to ensure that all storage components will lose power at the same moment. However, the UPS units may fail independently. Thus we strongly recommend that you dual-attach all storage components to both UPS units via separate power cords.

3.3.1 Solution with multiple UPS units and Redundant Switch

Note

Because the Redundant Switch can provide a maximum output of 3 kVA, this solution can be used only for clusters with a total power consumption of less than 6 kVA.

Using the APC Redundant Switch (see 2.3.3, "Redundant Switch" on page 16), you can attach a server redundantly to two power lines. Failure of one power line is hidden completely.

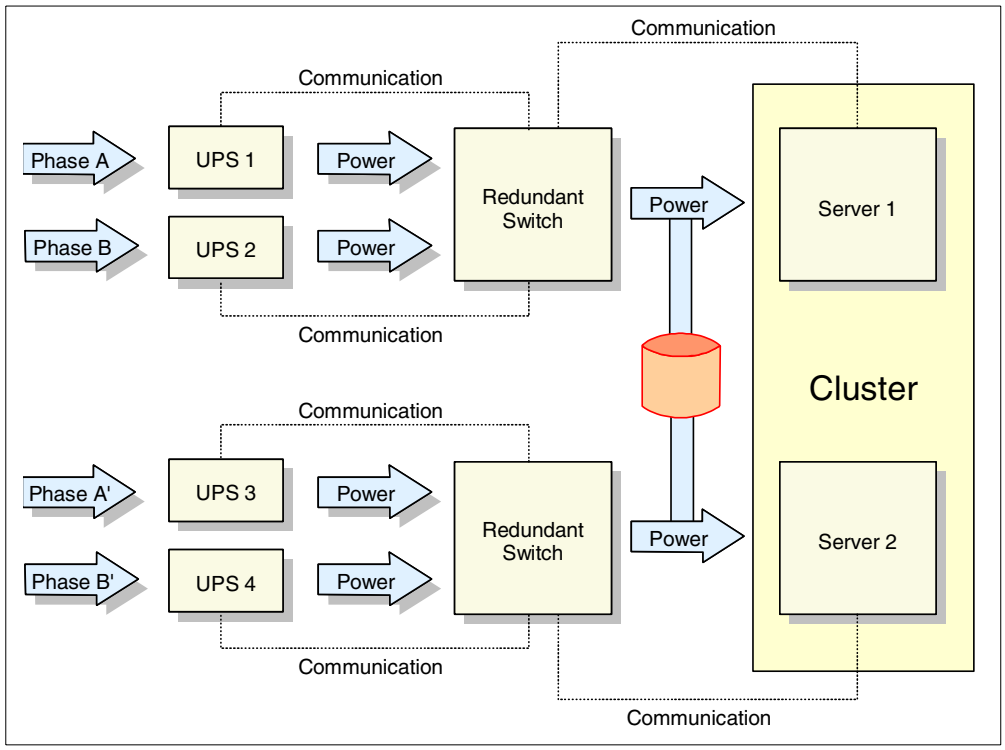


Figure 51. Multiple UPS units with Redundant Switch

UPS fault tolerance is provided by two independent phases (A, B) powering two pairs of UPS units. Each pair is connected to an APC Redundant Switch, which adds fault-tolerance in case one of the UPS or power line fails. UPS monitoring is replaced by monitoring of the Redundant Switches.

In the case of using different power phases in the same data center (Phase A = Phase A' and Phase B = Phase B'), the UPS software is installed in the same way as for a single power line solution (3.2, "Single power line solutions" on page 31). The only situation which affects the cluster is loss of all power. Thus the server status is always the same for both nodes.

This solution has not been tested during our project, and we will not discuss further details here.

3.3.2 Solution with two UPS units

The power cabling from Figure 52 on page 53 is often used in cluster configurations. The advantage is that — similar to the use of a Redundant Switch in the previous section — failure of one power line is hidden from the cluster.

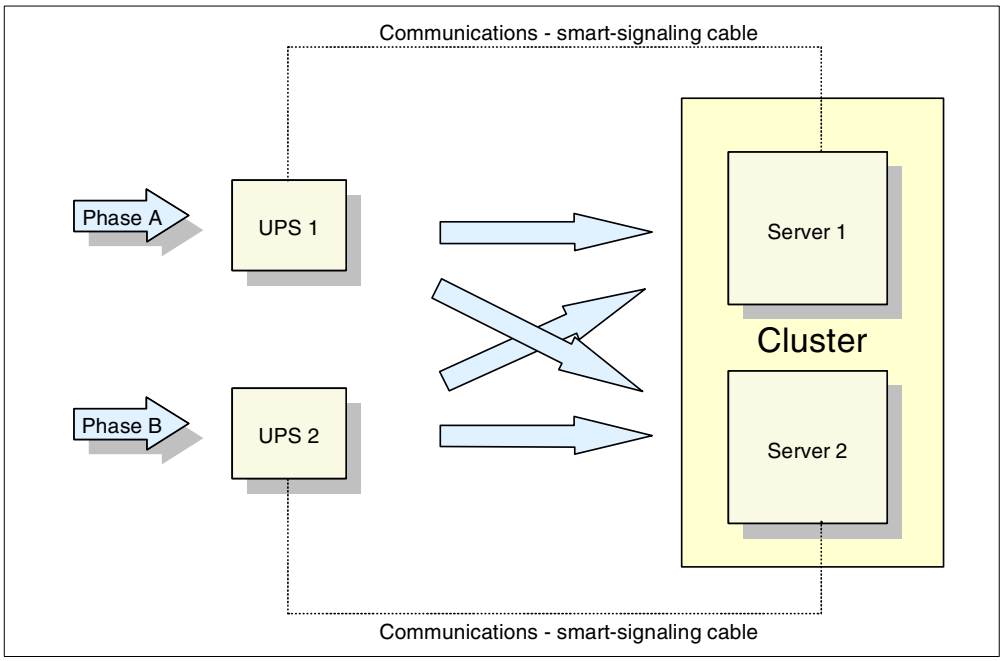


Figure 52. Two UPS units without application handling

But connecting the power cords in this way prevents correct application handling. Communication is possible only between one server and one UPS. Therefore, if a server receives a UPS signal, software on this server cannot check the power status of the second UPS. For example, phase B fails. Server 2 gets the signal from UPS 2. Should server 2 begin to shut down? For this decision, information about UPS 1 would be needed but is not available. Even if server 2 always decides for shutdown, a question would remain about bringing the applications offline or moving them to server 1.

This solution is appropriate when application handling is not required and the focus is on redundant power. An example is a file server cluster; losing power without executing an ordered shutdown is a risk for data consistency.

Figure 53 shows better cabling, which we recommend for correct UPS communication.

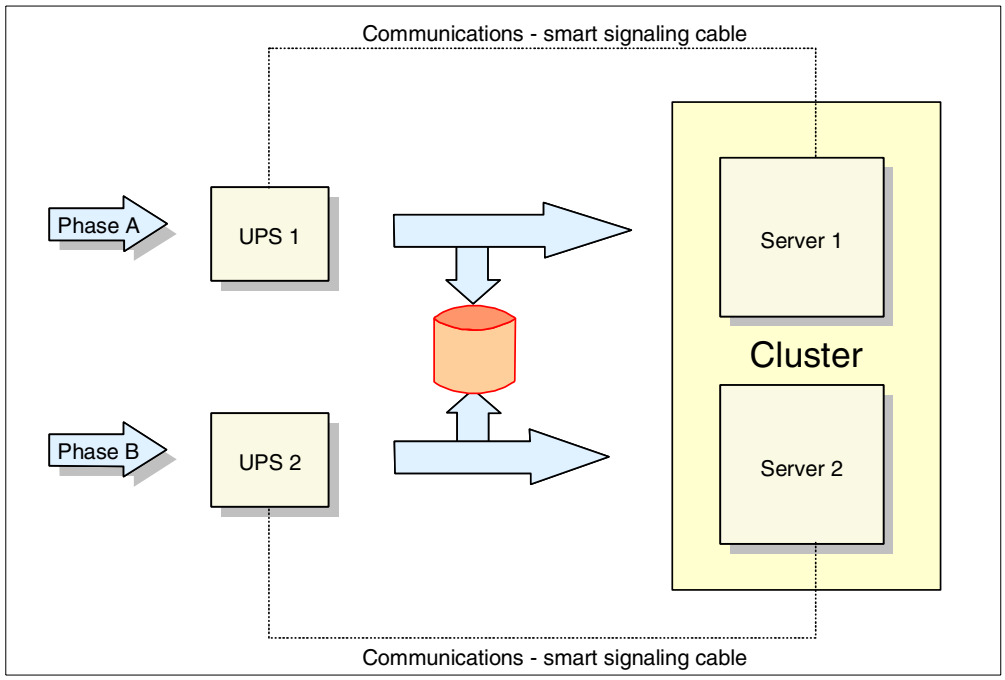


Figure 53. Two UPS units with application handling

This setup looks very similar to Figure 52 on page 53. The important difference is the one-to-one relation between UPS status and server status. In Figure 52, the status of a server is determined by the status of two UPS units, but the server can communicate with one UPS only. In this setup, however, each UPS influences the status of one server only. Each server monitors its own UPS. If the server receives a power loss signal, it always begins to shut down.

The way to handle applications on this node depends on the status of the other node. The other node may be:

1. Unaffected by the power failure (remaining available for cluster applications).
2. Unavailable (powered off, crashed, or unresponsive for other reasons).
3. Available but cannot be the target of a resource move operation.
4. Affected by a power loss but still running.

In terms of MSCS, status 1 corresponds to Node Up. This is the only status where the node can receive cluster resources. Status 2 means Node Down, not responding to a cluster heartbeat. Status 3 is Node Paused. A paused node may run cluster applications, but it will not accept more resources than currently owned. This can be used by the administrator to prevent overload or prepare for maintenance.

Status 4 is outside of MSCS's scope, but the time interval between UPS power loss and node shutdown is similar to Node Paused: The node is still running, but the node should not start additional applications. Thus we set a node that received the power loss signal to Node Paused.

Because the two cluster nodes are supplied by independent power lines, there is a chance that a power loss in one phase causes one node only to shut down.

What should a node do with cluster resources that are owned at the time of a power loss?

If the other node is in status Node Up, then this node is able to get the resources from the failing node. Because each node losing power sets its status to Node Paused, we avoid useless resource moves.

In any other case, the resources currently owned by the failing node must be brought offline. By bringing resources offline we ensure that applications shut down properly and we prevent unwanted failovers that would be aborted (causing problems when restarting).

These different cases are handled by the command file UPS.CMD. The command file is started by the Windows NT UPS service after a power failure. Depending on whether one node or both nodes are on battery, either a resource move or a cluster shutdown is performed.

3.3.3 Control flow in UPS.CMD

In the event of a UPS power loss, a delay (UPS On Battery Delay) is set. After this delay, the UPS service starts the UPS.CMD command file with the parameter UPSOnBattery.

The main task of the command file UPS.CMD is to call CLUSTER.EXE. This is a Microsoft Cluster Server utility program installed during cluster setup that can be used to administer clusters from the command prompt. The CLUSTER.EXE parameters are described in the *Microsoft Cluster Server Administrator's Guide*. We use this utility for three purposes:

- The local cluster node is paused. Pausing a node means that existing groups and resources stay online, but groups and resources cannot be brought online on this node. In this way, we ensure that a resource brought offline will not be restarted for any reason. Also the cluster node status Node Paused is an indicator for administrators that the command file takes control.
- Eventually, groups that are currently located on this node are brought offline. There are two exceptions: the quorum disk cannot be brought offline. The Cluster Group contains the cluster name and IP address that must remain available for executing CLUSTER.EXE commands.
- Eventually, groups that are currently located on this node are moved to the surviving node.

Details of the command file UPS.CMD are discussed in Chapter 4, "The command file UPS.CMD" on page 67.

Finally the operating system will be shut down. After the period specified in UPS Turn Off Delay, the servers will be powered off.

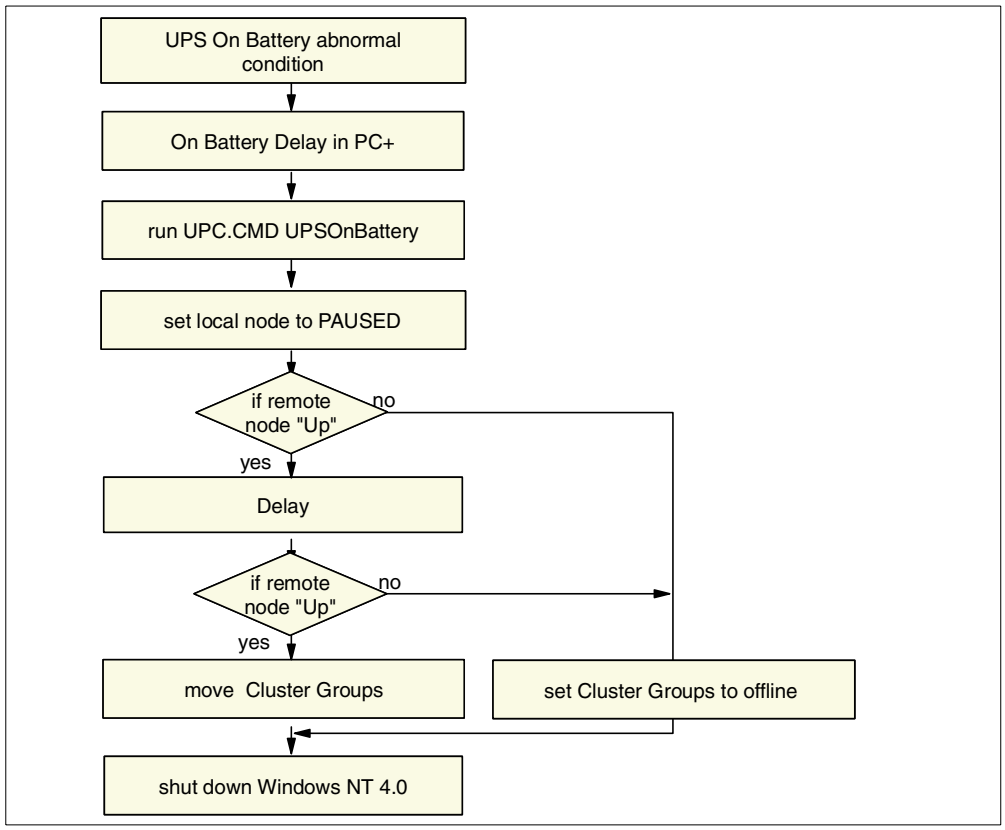


Figure 54. Double UPS flowchart

The flowchart shown in Figure 54 has three branches. The UPS On Battery condition is signaled by the UPS. PowerChute PLUS recognizes this condition and starts the UPS.CMD command file with the parameter UPSOnBattery. The command file sets the node status to Node Paused. Then a branch block contains three queries with a delay between them. If any query delivers the result that the remote node is not Node Up, then it is impossible to move any resource to the remote node. Therefore all groups will be set to offline except quorum disk and Cluster Group. If both queries deliver the result that the remote node is Node Up, then all resources will be moved to the remote node including quorum disk and Cluster Group. After either setting the resources offline or moving them to the remote node, the operating system shuts down.

The delay is implemented to ensure that if both systems start the script at exactly the same time, the state of the other node is detected correctly during the second query.

The operating system shutdown is started from the command file, not by using the PowerChute PLUS Shut Down Server action. When using this action, the server would be stopped after a maximum delay of 300 seconds. Since the time necessary to take a resource offline or move a resource varies, 300 seconds might be too short. Therefore, the script uses the SHUTGUI.EXE tool from the Microsoft Windows NT Resource Kit CD.

The three failure scenarios in 3.3, “Solutions with double power lines” on page 51 are handled as follows:

1. One power line works properly and the other fails

   All resources are moved to the surviving node. If the remote node has been set manually to Node Paused by the administrator, the script will run the branch “both power lines are failing”.

2. Both power lines fail at the same time

   Each node brings the resources offline (exceptions: quorum disk and Cluster Group).

3. At first one power line fails, later the second power line fails before all resource moves are completed

   One node begins actions as in scenario 1. Then the second power failure occurs. Groups that are still on the node with the first failure also go offline. Groups already moved to the node with the second failure will first go online and then be taken offline.

3.3.4 Example configuration with two UPS units

We used an MSCS solution with two IBM Netfinity 8500 servers (8681), an IBM Fibre Channel RAID Controller (3526) with six IBM EXP15 (3520) enclosures and two IBM Fibre Channel hubs (3523). We installed this cluster with two redundant Fibre Channel loops.

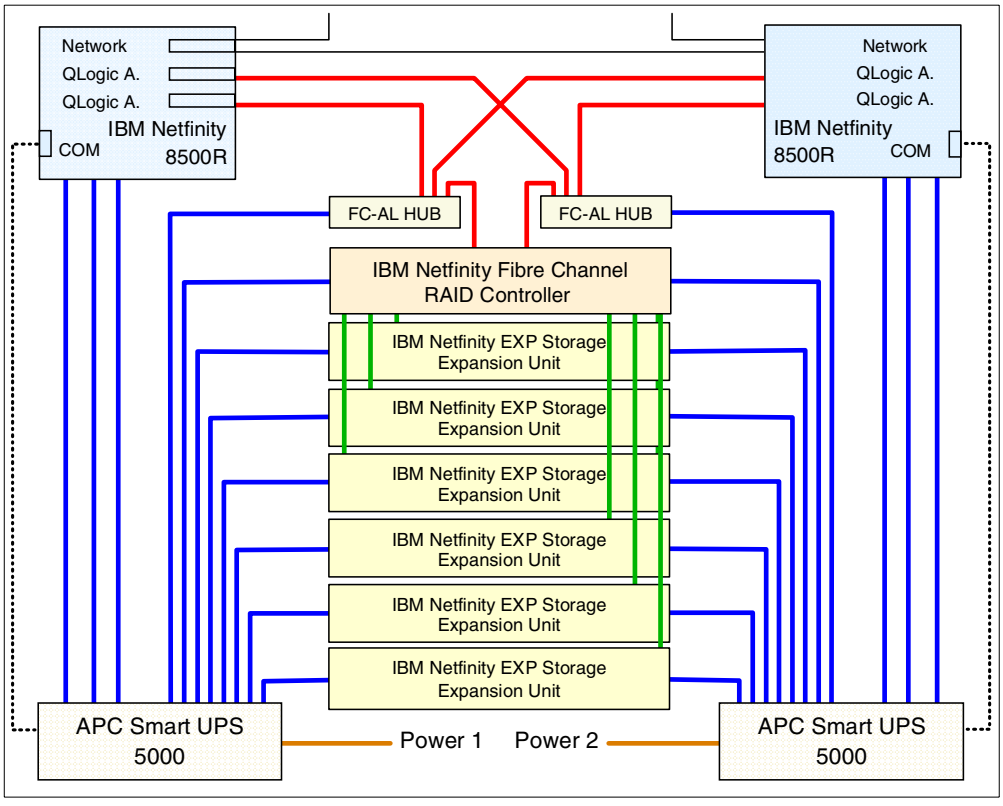


Figure 55. Double UPS

All power supplies of one Netfinity are connected to one APC SMART-UPS 5000. The power supplies of the RAID controller and the enclosures are connected to

both APC SMART-UPS 5000 for redundancy. The hubs are connected only to one APC SMART-UPS 5000 because they have only one power supply. Each Netfinity is connected with its UPS via a black serial cable (940-0024C).

The left node is named NF8500L, the right node NF8500R.

3.3.5 Preparing both nodes

To implement our solution, additional files are necessary, as follows:

1. Create a new directory C:\UPS_CMD.
2. For Windows NT, download the file UPS.CMD as described in Appendix A, “Downloading the additional material” on page 73. For Windows 2000, download UPS.CMD.W2K and rename it to UPS.CMD.
3. Download the DELAY3.EXE as described in Appendix A, “Downloading the additional material” on page 73.
4. Copy the file SHUTGUI.EXE from the Windows NT Resource Kit CD to C:\UPS_CMD.

As result, you should have a directory similar to Figure 56.

```
C:\>tree ups_cmd /f
Directory PATH listing for volume NTWKS
Volume serial number is 0012FC94 166F:1BD3
C:\UPS_CMD
    ups.cmd
    shutgui.exe
    delay3.exe

No subdirectories exist

C:\>
```

Figure 56. Directory view

3.3.6 Installing PowerChute PLUS on both nodes

Each node is connected via a black smart-signaling cable to their corresponding UPS; thus, the installation is identical on both nodes. The following steps have to be made on both nodes:

1. Install PowerChute PLUS 5.2 for Windows NT 4.0. You can download PowerChute PLUS from:

   `http://www.apcc.com/tools/download/`

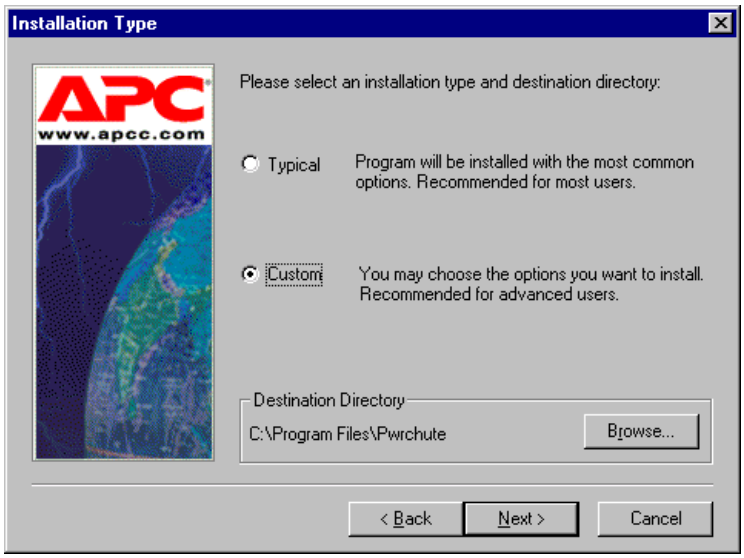

Installation Type
www.apcc.com
Please select an installation type and destination directory:
Typical
Program will be installed with the most common options. Recommended for most users.
Custom
You may choose the options you want to install. Recommended for advanced users.
Destination Directory
C:\Program Files\Pwrchute
Browse...
< Back
Next >
Cancel

Figure 57. Install PowerChute PLUS — choose type of installation

1. Select the **Custom** option and click **Next.** This displays Figure 58.

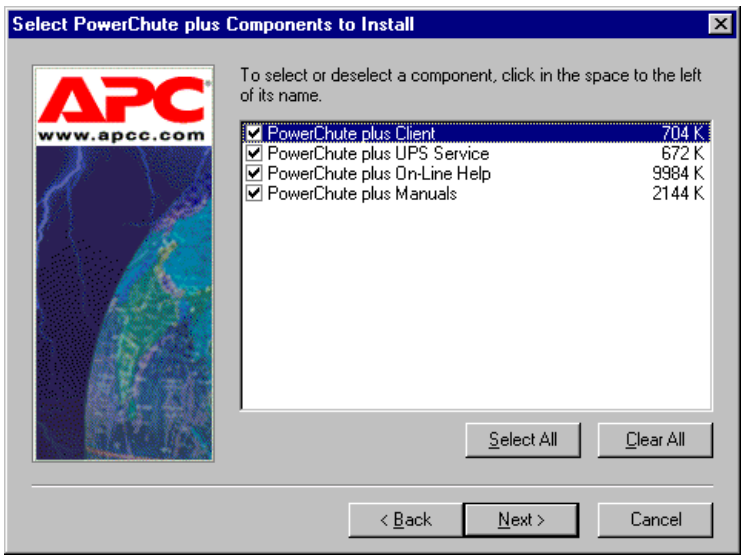

Select PowerChute plus Components to Install
www.apcc.com
To select or deselect a component, click in the space to the left of its name.
PowerChute plus Client 704 K
PowerChute plus UPS Service 672 K
PowerChute plus On-Line Help 9984 K
PowerChute plus Manuals 2144 K
Select All
Clear All
< Back
Next >
Cancel

Figure 58. Install PowerChute PLUS — select components to install

2. Select the boxes to install the components you wish to install. Select **PowerChute PLUS Client** and **the PowerChute PLUS UPS Service**. The other components are optional. Click **Next** to display the Select Components window shown in Figure 59.

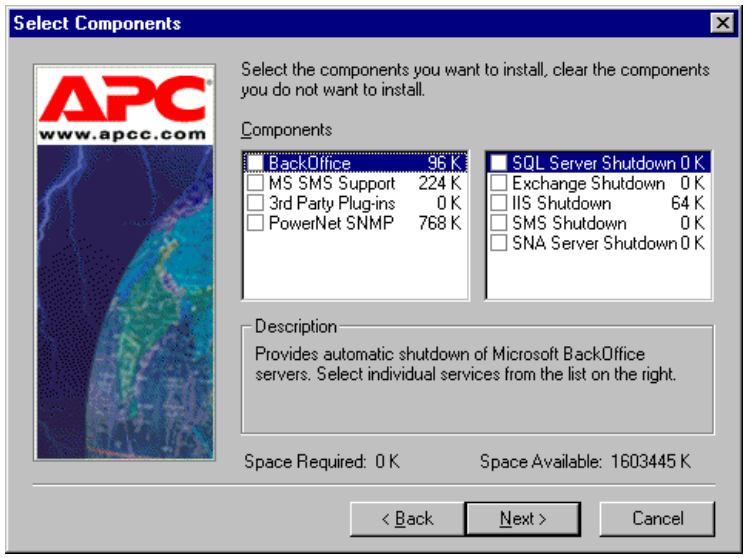

Select Components
APC
www.apcc.com
Select the components you want to install, clear the components you do not want to install.
Components
BackOffice 96 K
MS SMS Support 224 K
3rd Party Plug-ins 0 K
PowerNet SNMP 768 K
SQL Server Shutdown 0 K
Exchange Shutdown 0 K
IIS Shutdown 64 K
SMS Shutdown 0 K
SNA Server Shutdown 0 K
Description
Provides automatic shutdown of Microsoft BackOffice servers. Select individual services from the list on the right.
Space Required: 0 K
Space Available: 1603445 K
< Back
Next >
Cancel

Figure 59. Install PowerChute PLUS — automatic shutdown components

3. Do not check any boxes of these components for automatic application shutdown. Click **Next**. The window shown in Figure 60 will be displayed.

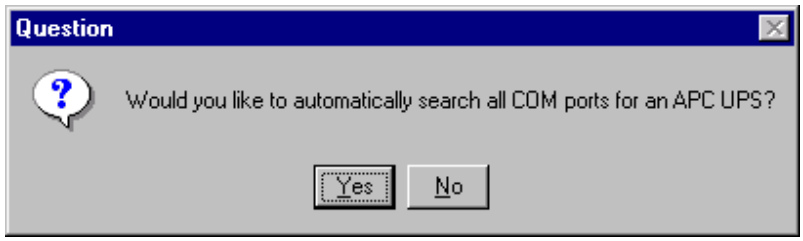


Figure 60. Install PowerChute PLUS — select UPS parameters

4. First, make sure that the current node's COM port is connected via a smart-signaling cable to the PC interface port of the corresponding UPS. The smart-signaling cable is a black cable with the part number 940-0024C (a short cable) or 940-1524C (a longer cable).
5. Click the **Yes** button to automatically detect the UPS. The UPS will be found by the installation program and Figure 61 will be displayed.

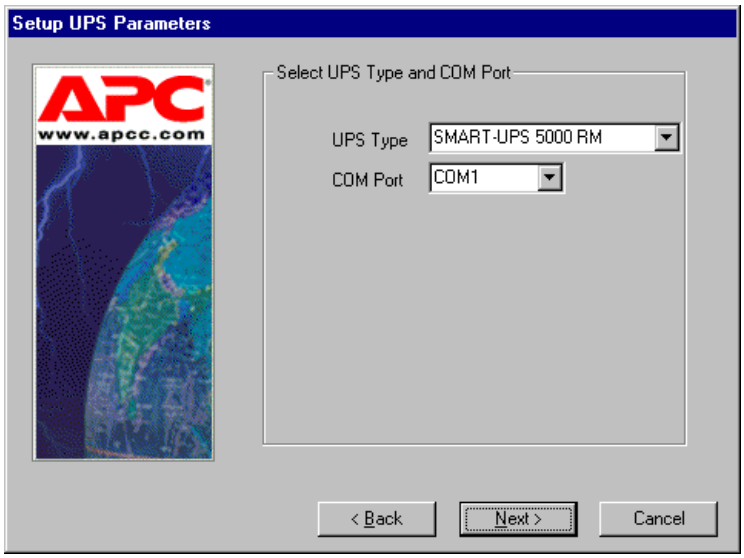


Figure 61. Install PowerChute PLUS — automatically detect the UPS

6. Your UPS has been discovered correctly. Otherwise you can select the UPS type and COM port manually from the pull-down menus. Click the **Next** button and Figure 62 will be displayed.

.

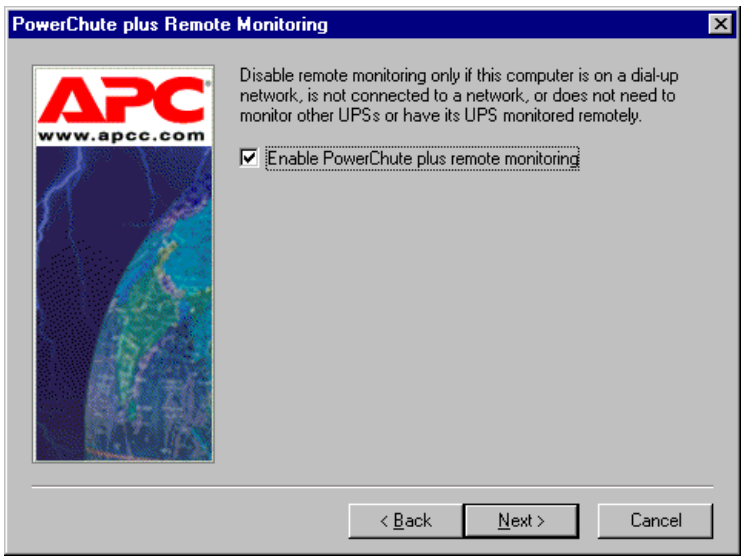

PowerChute plus Remote Monitoring
www.apcc.com
Disable remote monitoring only if this computer is on a dial-up network, is not connected to a network, or does not need to monitor other UPSs or have its UPS monitored remotely.
Enable PowerChute plus remote monitoring
< Back
Next >
Cancel

Figure 62. Install PowerChute PLUS — remote monitoring

7. In this window, check the box to enable the PowerChute PLUS remote monitoring function. For details see the PowerChute PLUS documentation.
8. Finish the installation by clicking **Next**. If you wish, you can now register your hardware and software with APC.

3.3.7 Configuring PowerChute PLUS

Now we configure the time intervals as shown in Figure 19 on page 28, and we define the actions according to the events as described in 2.4.1.3, “PowerChute events” on page 19. The following steps have to be made on both nodes:

1. Start PowerChute PLUS. You see a window (shown in Figure 63) with all servers in the same IP subnet segment where the PowerChute PLUS software is installed.

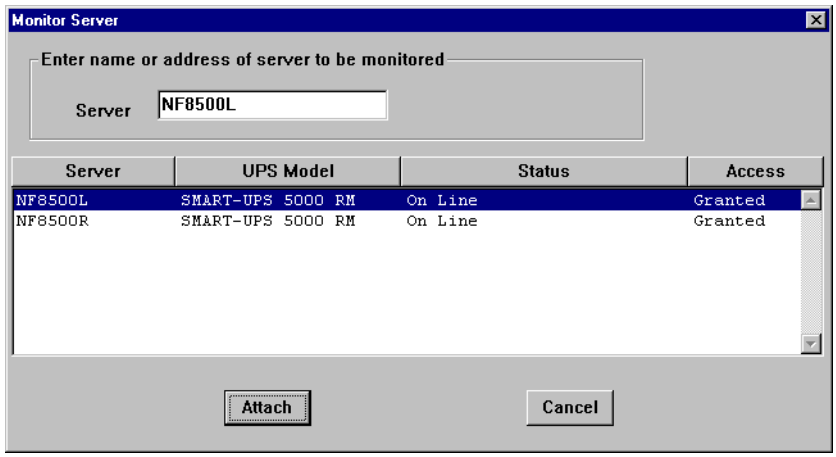


Figure 63. Double UPS Monitor Server

2. Select the current node and click the **Attach** button. This will display the PowerChute PLUS main window, shown in Figure 64.

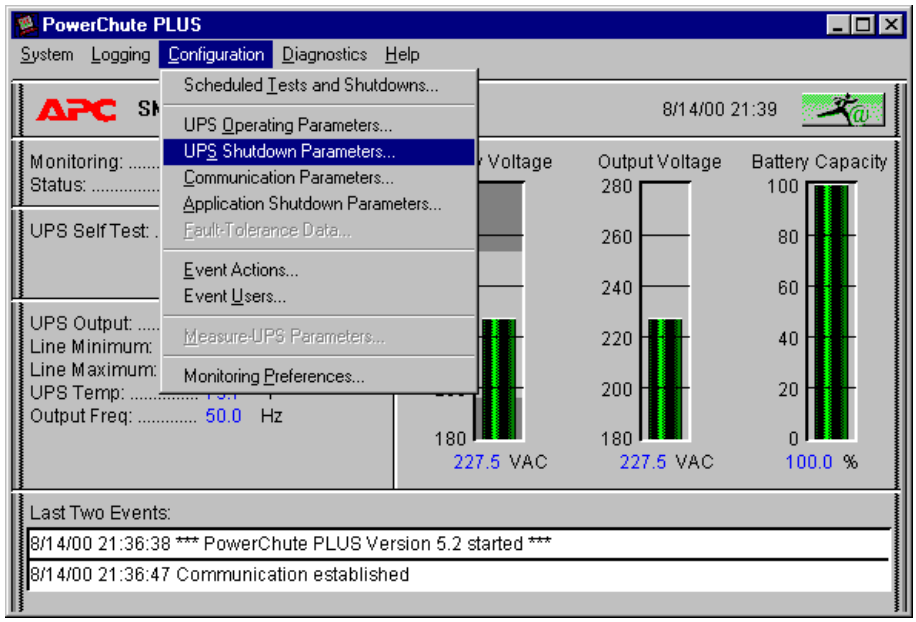


Figure 64. PowerChute PLUS — main window

3. In the PowerChute PLUS main window, select **Configuration > UPS Shutdown Parameters**. Figure 65 will be displayed.

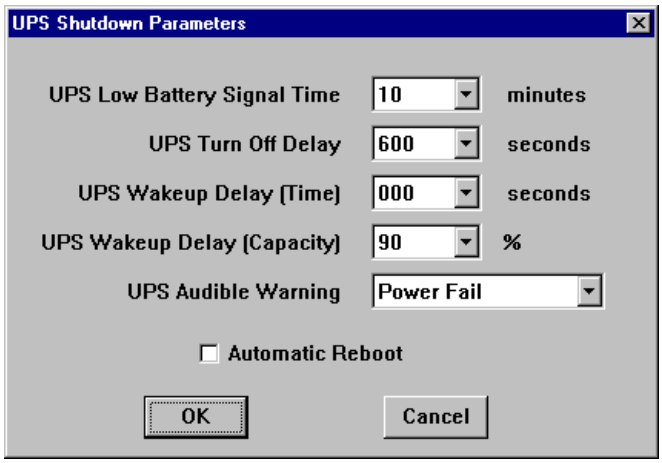


Figure 65. UPS Shutdown Parameters window

4. On the Shutdown Parameters window, enter the following parameters:
   - **UPS Low Battery Signal Time**: This condition will occur if the battery is very old and the UPS can supply power for a short period only (thus immediate actions are required). It is the minimum number of minutes of battery run time that the UPS needs to perform the essential tasks of a safe system shutdown. Possible values are 2, 5, 7, and 10 minutes. We recommend 10 minutes to get enough time for shutdown.
   - **UPS Turn Off Delay**: This period of time begins at power loss. After this interval, the UPS turns off its output power (independent of any shutdown completion). If line voltage returns during this period, turnoff of output power is canceled (again independent of any shutdown operations in progress). Possible delay values are 20, 180, 300, and 600 seconds. We recommend to set the value as estimated in the time line (Figure 19 on page 28).
   - **UPS Wakeup Delay (Time)**: This is the time that the UPS must be connected to a functioning power line before the attached systems can be powered up. Possible delay values are 0, 60, 180, and 300 seconds. Again, we recommend the maximum value of 300 seconds (to avoid system boot in situations with short-time power return only). Additionally, a percentage of full capacity for recharge may be specified as **UPS Wakeup Delay (Capacity)**.

   Once you have set the parameters, click the **OK** button.
5. In the PowerChute PLUS main window (Figure 64 on page 62), select **Configuration > Application Shutdown Parameters**. Figure 66 will be displayed.

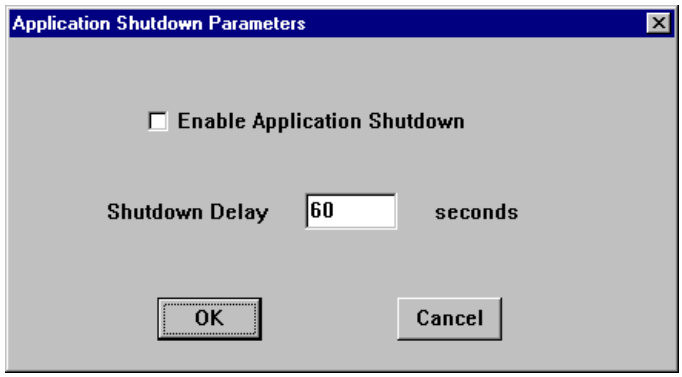


Figure 66. Double UPS Application Shutdown Parameters window

6. Disable the application shutdown (because this will be handled by the command file UPS.CMD) and click the **OK** button.
7. In the PowerChute PLUS main window (Figure 64 on page 62), select **Configuration > Event Actions.** Figure 67 will be displayed.

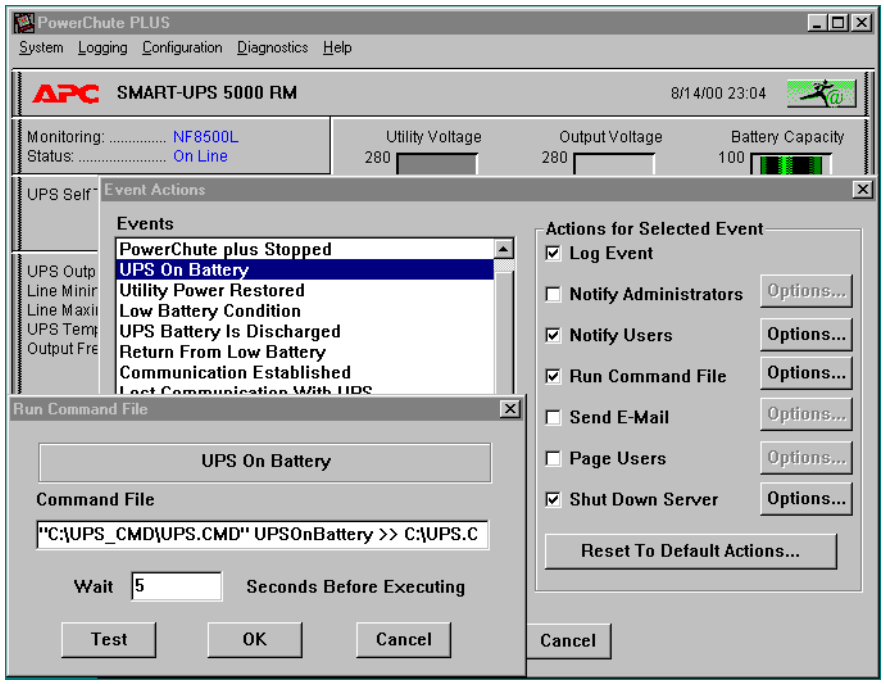


Figure 67. Double UPS Run Command File — UPS On Battery

8. In the Event Actions window, select **UPS On Battery**.
   a. Check the **Run Command File** checkbox and click **Options**. In the pop-up window, insert the following in the Command File field:

      "`C:\UPS_CMD\UPS.CMD`**"** `UPSOnBattery >> C:\UPS_CMD\LOG.TXT`

   b. Set the Wait value to 5 seconds. This wait time (UPS On Battery Delay in Figure 19 on page 28) before the command file is executed prevents short power failures from shutting down the cluster. Click the **OK** button to apply your choices.

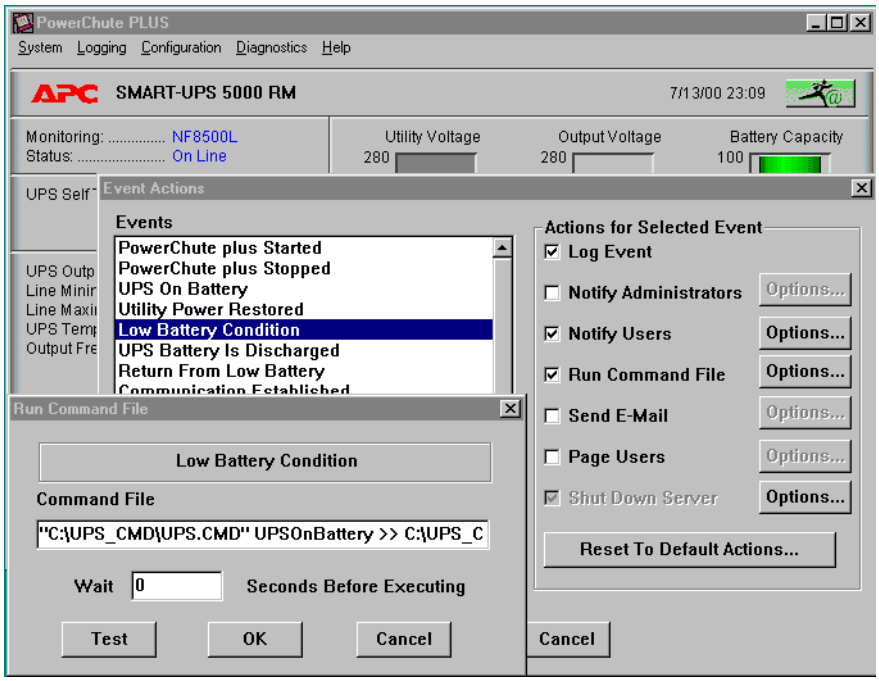


Figure 68. Double UPS Run Command File — Low Battery Condition

9. In the Event Actions window, select **Low Battery Condition**.
   a. Check the **Run Command File** checkbox and click **Options**.
   b. In the pop-up window, insert the following in the Command File field:

      `"C:\UPS_CMD\UPS.CMD" UPSOnBattery >> C:\UPS_CMD\LOG.TXT`

   c. Set the Wait value to 0 seconds. A low battery condition means that the UPS can only supply the systems for a short period, and immediate actions must take place. This wait time forces immediate execution of the command file when a low battery condition occurs. Click the **OK** button to apply your choices.

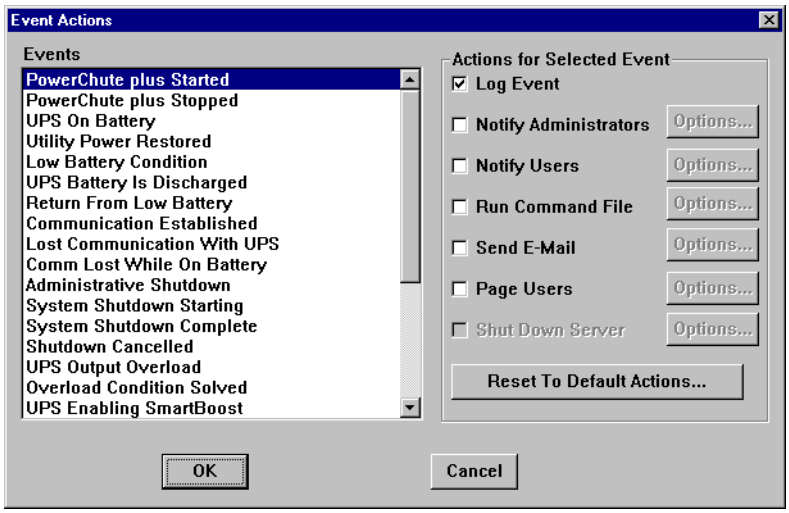


Figure 69. Double UPS Run Command File — PowerChute PLUS Started

10. In the Event Actions window, select **PowerChute PLUS Started**.

Clear the check in the **Run Command File** checkbox.

We strongly recommend that you do not start the cluster automatically. An administrator has to evaluate the situation and take the required measurements. Besides, it is mandatory to start the systems in a data center in a certain order (PDC, BDC, databases, etc.). Usually the MSCS is the last component to start.

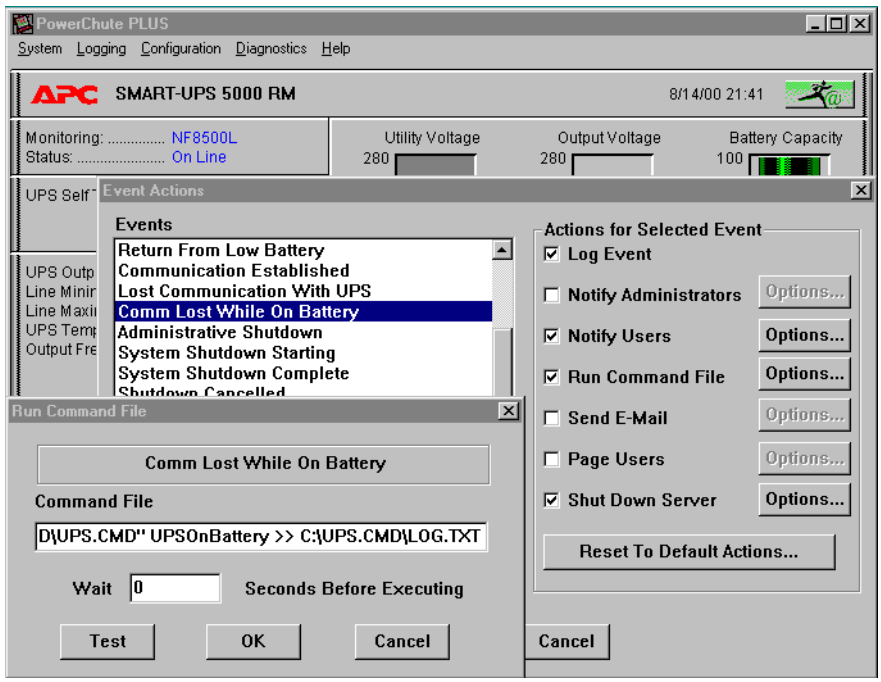


Figure 70. Double UPS Run Command File — Comm Lost While On Battery

11. In the Event Actions window, select **Comm Lost While On Battery**.
    a. Select the **Run Command File** checkbox and click **Options**.
    b. In the pop-up window, insert the following in the Command File field:

       "`C:\UPS_CMD\UPS.CMD`**"** `UPSOnBattery >> C:\UPS_CMD\LOG.TXT`

    c. Set the Wait value to 0 seconds. If the UPS is on battery and communication is lost, an immediate action is required because the state and run time of the UPS are unknown.

Chapter 4. The command file UPS.CMD

All actions necessary for shutting down a node in the cluster are performed by the command file UPS.CMD. The command file covers attachment of the cluster to one or two UPS units. Startup procedures may be implemented as well.

Downloading UPS.CMD

See Appendix A, “Downloading the additional material” on page 73 for insturctions on how to download UPS.CMD.

In this chapter, we explain the command file’s structure. Understanding of these internals is essentially because the administrator has to modify the file before using it. There are four sections that must be changed.

The command file has been designed and tested with Microsoft Windows NT 4.0 Enterprise Edition, English version only. A version for Windows 2000 is also available. See Appendix A, “Downloading the additional material” on page 73 for details on how to get them.

The UPS.CMD file is also listed in full in Appendix B, “UPS.CMD” on page 77.

This chapter discusses the main segments of the command file:

- 4.1, “Global Variables in the Command File UPS.CMD” on page 67
- 4.2, “Parameter UPSOnBattery” on page 68
  - Parameter UPSOnBattery — case: MoveClusterGroups
  - Parameter UPSOnBattery — case: GroupOffline
- 4.3, “Parameter SingleUPSOnBattery” on page 71
- 4.4, “StartUp Parameter” on page 72

4.1 Global Variables in the Command File UPS.CMD

Like most other programs, some variables defined at the beginning of the command file are used throughout the code. In lines 43 and 44, the names of the cluster nodes are defined. In our scenario we have chosen NF8500R and NF8500L.

```
043 SET NodeAName=NF8500R
044 SET NodeBName=NF8500L
```

Attention

The node names in lines 43 and 44 must be changed by the administrator.

The node name corresponds to the computer name in Microsoft Windows NT. The computer name is defined in the system environment variable COMPUTERNAME. The names have to be defined because the file relies on variables in order to use the same code on both nodes. This reduces the administrative efforts necessary to run the script.

In lines 49 and 50, the environment variable for the computer name is compared with variables defined in line 43 and 44.

```
049 IF %NodeAName% == %COMPUTERNAME% SET TheOtherNodeName=%NodeBName%
050 IF %NodeBName% == %COMPUTERNAME% SET TheOtherNodeName=%NodeAName%
```

This comparison is used to set the name of the remote node.

In line 56, a check for the start parameter is made. If there is no parameter provided, then (after a jump to line 188) a message shows the possible start parameters StartUp, UPSOnBattery and SingleUPSOnBattery.

```
056 IF s%1 == s GOTO ERROR1

188 :ERROR1
189
190 ECHO You must run this script with one parameter with the action that
should be do!
191 ECHO use StartUp
192 ECHO use UPSOnBattery
193 ECHO use SingleUPSOnBattery
194 GOTO END
```

The code in lines 57 to 59 analyzes the start parameter and branches to the corresponding label in the command file.

```
057 IF %1 == StartUp GOTO StartUp
058 IF %1 == UPSOnBattery GOTO UPSOnBattery
059 IF %1 == SingleUPSOnBattery GOTO SingleUPSOnBattery
```

If the parameter is wrong, then (after a jump to line 188) the message about possible start parameters StartUp, UPSOnBattery and SingleUPSOnBattery is displayed.

4.2 Parameter UPSOnBattery

As explained in 3.2, “Single power line solutions” on page 31, and 3.3, “Solutions with double power lines” on page 51, the same command file handles configurations with one UPS as well as two UPS units. In both scenarios, PowerChute PLUS launches the command file at the UPS on Battery event (after the UPS On Battery Delay). The startup parameter indicates which type of configuration has to been handled (for example with two UPS units, see Figure 66 on page 64).

A parameter value UPSOnBattery means a configuration with two UPS units. This is explained below. The parameter value SingleUPSOnBattery in the case of a single UPS is discussed in 4.3, “Parameter SingleUPSOnBattery” on page 71.

If the condition in line 58 is fulfilled, then we have the case of two UPS units. The code for this case begins on line 89.

As a first step, the node that runs the command file enters Node Paused status (line 92).

```
092 CLUSTER . NODE %COMPUTERNAME% /PAUSE
```

Second, the node checks (line 94) if the remote node has a status of Node Up.

```
094 CLUSTER.EXE %TheOtherNodeName% NODE %TheOtherNodeName% | FIND "Up"
```

The result of this check is required for the decision whether the Cluster Groups will be moved to the remote node or brought offline. Note that the code looks for English output from CLUSTER.EXE. In a non-English version of Microsoft Windows NT 4.0, this may fail! Thus, if you use another language, you have to verify the code.

In line 95, the error level of the previous line is analyzed:

```
095 IF %errorlevel% == 1 GOTO GroupOffline
```

If the Up string was not found in the output of CLUSTER.EXE, then we make the assumption that the remote node is either in a status of Node Down or Node Paused. In every case, the resources must not be moved. The resources have to be set offline, which is done in line 141 (`GroupOffline` label).

Otherwise, if the result is that the other node is up, then the node with the name specified in the variable NodeBName will delay execution for three further seconds:

```
097 IF %COMPUTERNAME == %NodeBName%  C:\UPS_CMD\DELAY3 3
```

This is necessary if both nodes reach line 94 at the same time. If both power lines fail at exactly the same moment, then there is some uncertainty about which node status is seen. It may be that one node changes to a status of Node Paused some fractions of seconds later. To avoid a wrong decision by the other node, we enforce a difference in timing here. There is no command available to do so from the default Windows NT shell. We developed the small tool DELAY3.EXE, which can be downloaded as described in Appendix A, “Downloading the additional material” on page 73. The status of the other node is probed again (lines 100 and 101), and the final decision about moving the resources is made:

```
100 CLUSTER.EXE %TheOtherNodeName% NODE %TheOtherNodeName% | FIND "Up"
101 IF %errorlevel% == 1 GOTO GroupOffline
```

If the remote node is detected as Node Up during the second check, the move of the groups will be initiated (in line 103: jump to line 116). This is described in the next section. If any other node status was returned, then the resource groups must be brought offline (4.2.2, “GroupOffline” on page 70).

4.2.1 MoveClusterGroups

Note

It is mandatory that the administrator enters one line for each resource group which should be moved to the surviving node when one node shuts down (below line 125).

```
126 cluster . GROUP "VFS_a" /MOVETO:%TheOtherNodeName% > NUL
127 cluster . GROUP "VFS_b" /MOVETO:%TheOtherNodeName% > NUL
```

One line is required for each resource group. The dot after the command cluster denotes the cluster to which the local node belongs. The name of the group has to be specified in quotation marks after the parameter GROUP. The parameter

/MOVETO initiates moving of a resource to the node specified. Note that we don't add a /WAIT parameter; thus all commands are issued asynchronously.

The command in line 136 sends a network message to the domain (in our scenario, the domain APC) about the steps initiated by the script.

```
136 NET SEND /DOMAIN:APC "The groups are moved from node %COMPUTERNAME% to
    %TheOtherNodeName% and will be shutdown in 2 minutes!"
```

Now the resource handling is completed, and shutdown of the operating system begins (in line 137 jump to line 179).

```
137 GOTO Shutdown
```

With the application SHUTGUI.EXE from the Microsoft Windows NT Resource Kit, shutdown of the operating system is initiated finally (line 182).

```
182 C:\UPS_CMD\SHUTGUI.EXE /L /T:120 "A power loss has occurred !" /C
```

The command file utilizes SHUTGUI.EXE (instead of the PowerChute PLUS Shut Down Server action) to ensure that the operating system shutdown begins after resource handling (independent of PowerChute PLUS timers).

The parameter /L forces the local machine to shut down with a delay of /T seconds. During shutdown, the message in quotation marks will be displayed. /C means that applications will be forced to stop without any input.

Note: If you use the /C parameter, NT ignores the application's option to save data which may have changed. You will not see any File-Save dialog box because Windows NT forces the application to stop immediately. This will result in loss of all data previously not saved.

4.2.2 GroupOffline

In the section above, we discussed the case when one node survives a power outage. Now we will discuss when both nodes begin to shut down. If the final query about the remote node status (line 100) doesn't return Node Up, bringing the groups offline is initiated (jump to label GroupOffline).

Attention

It is mandatory that the administrator enter a three-line section for each resource group that should be brought offline (after line 154).

Beginning with line 163 for each group of the cluster, the following lines have to be inserted in the command file:

```
163 :off3
164 cluster . GROUP "VFS_a" /OFFLINE /WAIT:30 > NUL
165 IF %errorlevel% == 5023 GOTO off3
```

The jump backwards to label `:off3` is used to verify the return value of CLUSTER.EXE. If necessary, the command is repeated. The numbering of the labels is performed with consecutive values. `Labels :off1` and `:off2` are reserved for the Cluster Group and the group containing the quorum disk.

According to recommendations from Microsoft, there should no application resources belonging to the Cluster Group (see `http://support.microsoft.com/support/kb/articles/Q168/9/48.ASP`). It is not necessary to set the Cluster Group offline. Hence, it is not required to bring the Cluster Group online after restart; the cluster name and IP address will be accessible via network automatically.

The group with the quorum disk is a special case because the quorum disk itself cannot be brought offline. This does not matter because the quorum disk should be used for the quorum log only. Thus the quorum disk will not belong to an application-related resource group. In our example, we created a separate Quorum group. Another usual way is to move the quorum disk into the Cluster Group (as default with Windows 2000). However, the quorum resource must be ignored by the command file.

The dot after the command cluster in line 164 denotes the cluster to which the local node belongs. The name of the group has to be specified in quotation marks after the parameter GROUP. As action /OFFLINE takes place. In contrast to the case of moving groups (4.2.1, “MoveClusterGroups” on page 69), here the commands are executed synchronously. If the command does not complete within 30 seconds successfully, the command is aborted. The wait time is application-specific and must be adjusted to the configuration. The next line allows a low-level error control: Error code 5023 means that the group is currently in “Online Pending” status. Setting the group offline can take place as soon as the pending phase is over.

The command file utilizes SHUTGUI.EXE (instead of the PowerChute PLUS Shut Down Server action) to ensure that the operating system shutdown begins after resource handling (independent of PowerChute PLUS timers).

With the application SHUTGUI.EXE from the Microsoft Windows NT Resource Kit, shutdown of the operating system is initiated finally (line 182).

```
182 C:\UPS_CMD\SHUTGUI.EXE /L /T:120 "A power loss has occurred !" /C
```

The parameter /L forces the local machine to shut down with a delay of /T seconds. During shutdown, the message in quotation marks (`"A power loss has occurred !"`) will be displayed. /C means that applications will be forced to stop without any input.

Note: If you use the /C parameter, Windows NT ignores the application’s option to save data that may have changed. You will not see any File-Save dialog box because Windows NT forces the application to stop immediately. This will result in loss of all data previously not saved.

4.3 Parameter SingleUPSOnBattery

As explained in 3.2, “Single power line solutions” on page 31, and 3.3, “Solutions with double power lines” on page 51, the same command file handles configurations with one UPS as well as two UPS units. In both scenarios, PowerChute PLUS launches the command file at the UPS on Battery event (after the UPS On Battery Delay). The startup parameter indicates which type of configuration has to been handled (for example with one UPS; see Figure 35 on page 41).

A parameter value SingleUPSOnBattery means a configuration with one UPS. This is explained below. The parameter value UPSOnBattery in the case of two UPS units was discussed in 4.2, “Parameter UPSOnBattery” on page 68.

If the condition in line 59 is fulfilled, then there is one UPS. The code for this case begins on line 107:

```
107 IF %1 == SingleUPSOnBattery GOTO SingleUPSOnBattery
```

As the first step, the node that runs the command file enters the Node Paused status (line 110):

```
110 CLUSTER . NODE %COMPUTERNAME% /PAUSE
```

As the second step, all groups are brought offline (jump to label GroupOffline):

```
112 GOTO GroupOffline
```

The actions to bring the resource groups offline are the same as described in 4.2.2, “GroupOffline” on page 70.

4.4 StartUp Parameter

In the StartUp section, actions can be defined that have to be performed after the power is reestablished and the system is restarted. PowerChute PLUS generates a PowerChute PLUS Started event. You may configure the event action to launch UPS.CMD with the StartUp parameter.

However, we don’t recommend automatic recovery after a power failure for several reasons:

- In a data center, a lot of services relay on each other. For example, connection to a domain controller is needed to start the cluster service. This requires not only a PDC or BDC, but also stable network connections. Therefore, an administrator intervention is useful to analyze the status of such components before starting production systems.
- There is a possibility that a resource operation might be aborted by an operating system shutdown. According to Microsoft, resource operations are not atomic (*Windows NT 4.0 Enterprise Edition, Release Notes*). In case of an aborted operation, you cannot accurately predict the status of all resources at the moment of restart.
- With Windows 2000, the power management differs from Windows NT 4.0. At the end of an operating system shutdown, the machine is powered off automatically. When power is reestablished, the server must be switched on by pressing the power button.

Thus we don’t discuss further details here.

Appendix A. Downloading the additional material

The programs and CMD files shown in Appendix B, “UPS.CMD” on page 77 and Appendix C, “DELAY3.EXE source” on page 81 are also available from the IBM Redbooks Web server.

Point your Web browser to:

`ftp://www.redbooks.ibm.com/redbooks/REDP0402`

Case sensative

This FTP URL is case sensative — `REDP0402` is in uppercase.

Alternatively, you can go to the IBM Redbooks Web site at:

`ibm.com/redbooks`

Select the **Additional materials** and open the directory REDP0402.

Note for IBM employees

If you are a user behind the IBM firewall and you use Microsoft Internet Explorer, you may not be able to view the files on the FTP site. You may get the error:

```
425 Can't build data connection: Connection refused.
```

The workaround is to use Netscape Navigator instead.

A.1 Using the additional material

The additional material that accompanies this redpaper is as follows:

File name	*Description*
delay3.exe	Program to pause a command file
delay3.pas	Pascal source code for delay3.exe
ups.cmd	CMD file used to control a cluster UPS, for Windows NT
ups.cmd.w2k	CMD file used to control a cluster UPS, for Windows 2000 (rename to UPS.CMD)
readme.txt	readme file for this additional material, listed below

A.2 Readme

This file contains additional information to this redpaper. **Note:** Before you use this solution in a production environment, you must make comprehensive tests.

A.2.1 Windows NT 4.0

A.2.1.1 UPS.CMD and the StartUp Option

Some tests have shown that it may be useful to use the PowerChute Started event in PowerChute PLUS to resume the node in the cluster. If the other node then fails, this node can take over the resources from the failed node.

1. In the PowerChute PLUS main window, select **Configuration > Event Actions**.
2. In the Event Actions window, select the **PowerChute PLUS Started** event.
3. Select the **RunCommand File** checkbox and click **Options**. Insert the following in the Command File field:

```
"C:\UPS_CMD\UPS.CMD" StartUp >> C:\UPS_CMD\LOG.TXT
```

You must also change the UPS.CMD command file at point 2. Start the cluster Server. If the Cluster is already started at this moment, you get an error message that the service already started. Then resume the node.

A.2.1.2 PowerChute 5.2.1

We have written this redpaper with PowerChute PLUS Version 5.2. V5.2.1 is now available. This version varies somewhat from PowerChute PLUS Version 5.2. If you use a newer version than V5.2, we recommend that you perform intensive tests.

A.2.1.3 LOG.TXT

The output of the command file UPS.CMD will be written to C:\UPS_CMD\LOG.TXT. It may be possible to make this output more useful and more readable with some time or date commands in the UPS.CMD command file.

A.2.2 Windows 2000

A.2.2.1 ACPI or power management

If you install Windows 2000 on a new model of IBM PC server, Windows 2000 will automatically install the power management. However, you now have a problem: PowerChute PLUS shuts Windows 2000 down. After shutting down, Windows 2000 switches the system off. Then, the UPS powers off. As soon as the power failure is resolved, the UPS puts power on the power outlets but the server will not start because it was switched off before the UPS turned off the power.

In our opinion you use the function key to disable the power management function of Windows 2000 during the textmode setup of Windows 2000.

A.2.2.2 The UPS.CMD command file

The UPS.CMD command file as described in this redpaper will not work in Windows 2000. Instead, you should use UPS.CMD.W2K, rename this file to UPS.CMD, and configure your UPS as described in this redpaper.

The changes are:

- Enable the operating system shutdown function from PowerChute PLUS 5.2.1
- The script checks which resources are owned by the node and sets them offline or moves them
- Some small changes for the cluster command tool.

A.2.2.3 DELAY3.EXE

You should use SLEEP.EXE found in the Windows 2000 Resource Kit. This Microsoft tool works in the same way as DELAY3.EXE. The difference is the use of resources. SLEEP.EXE does not need as much CPU time as DELAY3.EXE.

A hint for Windows 2000 users: The quorum resource is no longer in a separate resource group. It is now in the Cluster Group.

Appendix B. UPS.CMD

```
001 @ECHO OFF
002 REM ************************************************************************
003 REM
004 REM UPS Handling with Microsoft Cluster Server
005 REM ========================================
006 REM
007 REM APC:
008 REM     Martin Zustak
009 REM     Peter Fuchs
010 REM
011 REM CSG:
012 REM     Hendrik Ernst
013 REM     Silvio Erdenberger
014 REM
015 REM IBM:
016 REM     Arwed Tschoeke
017 REM
018 REM Version:
019 REM     2000-08-10
020 REM
021 REM Description:
022 REM     This is the command file that will be launched by PowerChute plus with
023 REM     different startup parameters.
024 REM
025 REM Usage:
026 REM     UPS.CMD <parameter>
027 REM
028 REM where <parameter> is one of the following:
029 REM     StartUp
030 REM     UPSOnBattery
031 REM     SingleUPSOnBattery
032 REM
033 REM Warning:
034 REM     Before using this file in your cluster, you have to adapt the sections
035 REM     marked with exclamation signs (!!!) for your cluster configuration!
036 REM     There are four sections (1)-(4) which must be changed!
037 REM
038 REM ************************************************************************
039
040 REM !!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
041
042 REM (1) Enter your node names here!
043   SET NodeAName=NF850OL
044   SET NodeBName=NF850OR
045
046 REM !!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
047
048 REM ------------------------------------------------------------------------
049   IF %NodeAName% == %COMPUTERNAME% SET TheOtherNodeName=%NodeBName%
050   IF %NodeBName% == %COMPUTERNAME% SET TheOtherNodeName=%NodeAName%
051 REM ------------------------------------------------------------------------
052
053 REM ------------------------------------------------------------------------
054 :CheckParam1
055
056   IF s%1 == s GOTO ERROR1
057   IF %1 == StartUp GOTO StartUp
```

```
058   IF %1 == UPSOnBattery GOTO UPSOnBattery
059   IF %1 == SingleUPSOnBattery GOTO SingleUPSOnBattery
060 GOTO ERROR1
061 REM ----------------------------------------------------------------------------
062
063 REM ----------------------------------------------------------------------------
064 :StartUp
065
066 REM Set this node in the resume state
067   NET START "Cluster Server"
068   CLUSTER . NODE %COMPUTERNAME% /RESUME
069
070 REM Set the resources online state
071
072 REM !!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
073
074 REM (2) Enter one line as shown below
075 REM for each resource group which should be brought online automatically
076 REM during startup!
077
078 REM  CLUSTER . GROUP "Cluster Group" /ONLINE > NUL
079 REM  CLUSTER . GROUP "Quorum"        /ONLINE > NUL
080   CLUSTER . GROUP "VFS_a"         /ONLINE > NUL
081   CLUSTER . GROUP "VFS_b"         /ONLINE > NUL
082
083 REM !!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
084
085   GOTO END
086 REM ----------------------------------------------------------------------------
087
088 REM ----------------------------------------------------------------------------
089 :UPSOnBattery
090
091 REM Set this node in the pause state
092   CLUSTER . NODE %COMPUTERNAME% /PAUSE
093
094   CLUSTER.EXE %TheOtherNodeName% NODE %TheOtherNodeName% | FIND "Up"
095   IF %errorlevel% == 1 GOTO GroupOffline
096
097   IF %COMPUTERNAME == %NodeBName%  C:\UPS_CMD\DELAY3 3
098   C:\UPS_CMD\DELAY3 3
099
100   CLUSTER.EXE %TheOtherNodeName% NODE %TheOtherNodeName% | FIND "Up"
101   IF %errorlevel% == 1 GOTO GroupOffline
102
103   GOTO MoveClusterGroups
104 REM ----------------------------------------------------------------------------
105
106 REM ----------------------------------------------------------------------------
107 :SingleUPSOnBattery
108
109 REM Set this node in the pause state
110   CLUSTER . NODE %COMPUTERNAME% /PAUSE
111
112   GOTO GroupOffline
113 REM ----------------------------------------------------------------------------
114
115 REM ----------------------------------------------------------------------------
116 :MoveClusterGroups
117
```

```
118 REM Move groups to the other node
119
120 REM !!!!
```

```
176
177
178 REM ------------------------------------------------------------------------
179 :Shutdown
180
181 ECHO Initiating shutdown
182   C:\UPS_CMD\SHUTGUI.EXE /L /T:120 “A power loss is occured !” /C
183   GOTO END
184 REM ------------------------------------------------------------------------
185
186
187 REM ------------------------------------------------------------------------
188 :ERROR1
189
190 ECHO You must run this script with one parameter with the action that should be do!
191 ECHO use StartUp
192 ECHO use UPSOnBattery
193 ECHO use SingleUPSOnBattery
194 GOTO END
195 REM ------------------------------------------------------------------------
196
197
198 :END
```

Appendix C. DELAY3.EXE source

```
{*******************************************}
{ Delay3 tool                               }
{ written by Hendrik Ernst                  }
{ C 2000-04-05                              }
{*******************************************}
uses windos,wincrt,strings;
var TimeDelay,
    StartHour, StartMinute, StartSeconds,
    DelayHour, DelayMinute, DelaySeconds,
    StopHour, StopMinute, StopSeconds,
    OldSecond : word;
    Hour, Minute, Second, Sec100: Word;
    i, temp: word;
    Code: Integer;
    strHour, strMinute, strSeconds,
    strStopHour, strStopMinute, strStopSeconds,
    strTime,strStopTime:string;
begin
    if ParamCount <> 1 then
    begin

writeln('*********************************************************************************');
      writeln('* Written by Hendrik Ernst                                                  *');
      writeln('* Version 2000040703                                                        *');
      writeln('* C 2000-04-07                                                              *');

writeln('*********************************************************************************');
      writeln('*  No or too many parameters!                                               *');
      writeln('*                                                                           *');
      writeln('* Please use the following syntax:                                         *');
      writeln('* delay xxx                                                                 *');
      writeln('* where xxx are the seconds that should be waited.                          *');
      writeln('* The maximum time is 65000 Seconds                                        *');

writeln('*********************************************************************************');
    end
  else
    begin
      { Get text from command line }
      Val(ParamStr(1), TimeDelay, Code);
      { Error during conversion to integer? }
     if code <> 0 then
        Writeln('Error at position: ', Code)
      else
        if (TimeDelay > 0) AND (TimeDelay < 65001) then
        begin
          Writeln('Value = ', TimeDelay);
          GetTime(Hour, Minute, Second, Sec100);

          StartHour:=Hour;
          StartMinute:=Minute;
          StartSeconds:=Second;

          DelayHour:= TimeDelay div 3600;
          DelayMinute:=(TimeDelay - DelayHour * 3600) div 60;
          DelaySeconds:=(TimeDelay - DelayHour * 3600 - DelayMinute * 60);
```

```
          StopSeconds:=Second + DelaySeconds;
          Temp := 0;
          if StopSeconds >= 60 then
          begin
            StopSeconds := Stopseconds - 60;
            Temp := 1;
          end;
          StopMinute:=Minute + DelayMinute + Temp;
          Temp := 0;
          if StopMinute >= 60 then
          begin
            StopMinute := StopMinute - 60;
            Temp := 1;
          end;
          StopHour:=Hour + DelayHour + Temp;
          Temp := 0;
          if StopHour >= 24 then
          begin
            StopHour := StopHour - 24;
            Temp := 1;
          end;

          str(Hour,strHour);
          str(Minute,strMinute);
          str(Second,strSeconds);
          strTime:=strHour+ strMinute+ strSeconds;

          str(StopHour,strStopHour);
          str(StopMinute,strStopMinute);
          str(StopSeconds,strStopSeconds);
          strStopTime:=strStopHour+ strStopMinute+ strStopSeconds;

          while (strTime <> strStopTime) do
          begin
            GetTime(Hour, Minute, Second, Sec100);
            if OldSecond <> Second then write('.');
            OldSecond := Second;

            str(Hour,strHour);
            str(Minute,strMinute);
            str(Second,strSeconds);
            strTime:=strHour+ strMinute+ strSeconds;

          end;
          donewincrt;
        end
        else
        begin

writeln('*********************************************************************************');
          writeln('* Written by Hendrik Ernst                                              *');
          writeln('* Version 2000040703                                                    *');
          writeln('* C 2000-04-07                                                          *');

writeln('*********************************************************************************');
          writeln('*  No or too many parameters!                                           *');
          writeln('*                                                                       *');
          writeln('* Please use the following syntax:                                     *');
          writeln('* delay xxx                                                            *');
```

```
          writeln('* where xxx are the seconds that should be waited.                        *');
          writeln('* The maximum time is 65000 Seconds                                       *');

writeln('*************************************************************************************');
         end;
  end;
{donewincrt;}
end.
```

Appendix D. Referenced documents

- *IBM Netfinity 8500R Hardware Maintenance Manual* (8681-4RY, 4RG, 5RY, 5RG, 6RY, and 6RG), available from:
  ftp://ftp.pc.ibm.com/pub/pccbbs/pc_servers/37l5123.pdf
- *IBM Netfinity EXP15 Storage Expansion Unit Hardware Maintenance Manual* (Type 3520), available from
  ftp://ftp.pc.ibm.com/pub/pccbbs/pc_servers/10l9839.pdf
- *IBM Netfinity Fibre Channel Hardware Maintenance Manual*, available from
  ftp://ftp.pc.ibm.com/pub/pccbbs/pc_servers/19k2481.pdf
- Microsoft KB document, *Information About the Cluster Group*, available from:
  http://support.microsoft.com/support/kb/articles/Q168/9/48.ASP
- *Microsoft Cluster Server Administrator's Guide,* available from: ???????????

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